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DECEMBER 20, 1928

Engineering News-Record

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JAMES BRINDLEY

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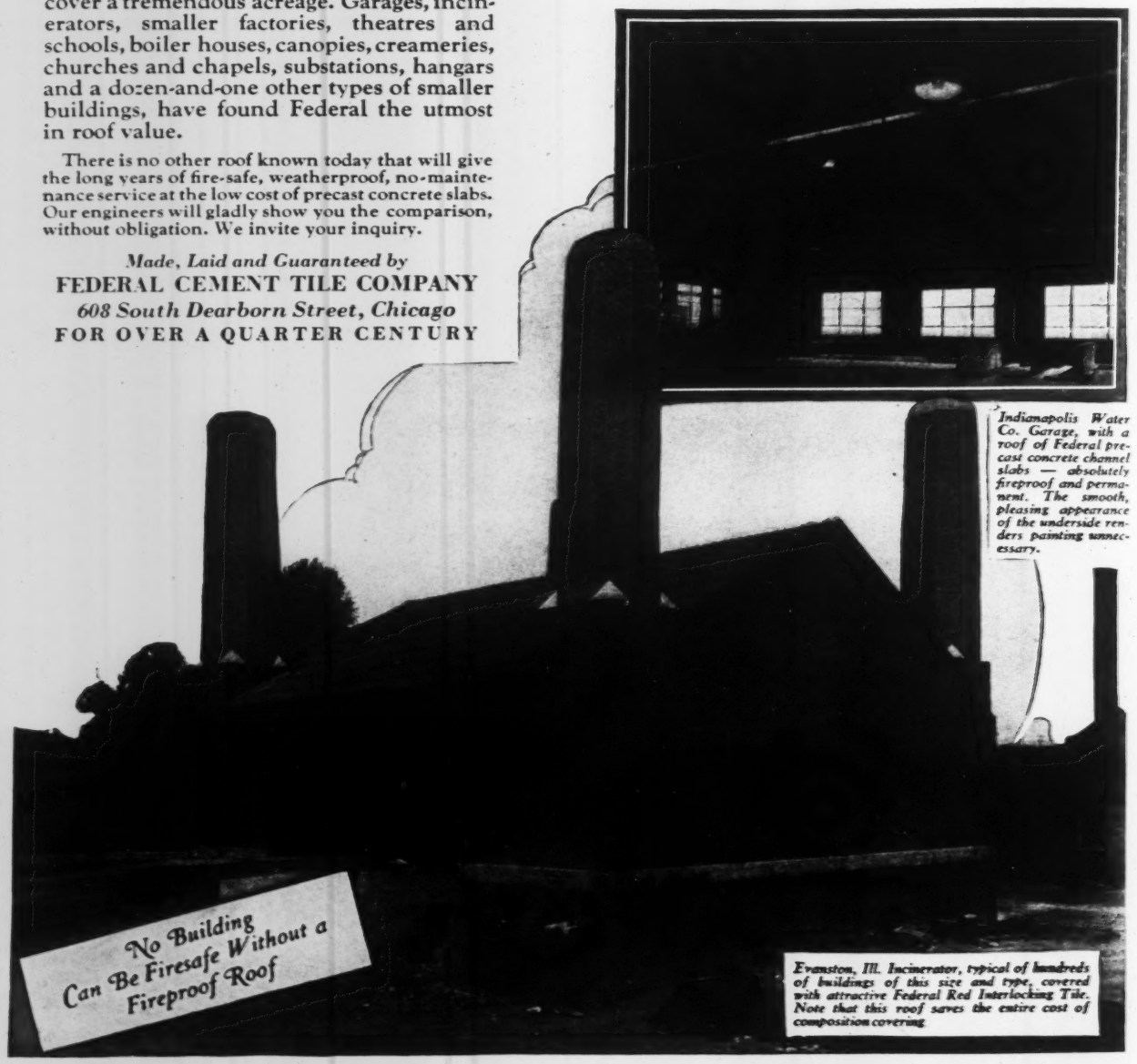

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New York, December 20, 1928

Engineering News-Record

A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

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The index for the current volume of *Engineering News-Record*, July to December, 1928, is to be published early in January and will be sent to each subscriber with the issue of Jan. 3, 1929.

A consolidated index of *Engineering News-Record* for the five-year period, 1923-1927 inclusive, was published in November. Copies of it are still available. The price is $4.

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VIRGINIA
ELECTRIC *and* POWER CO.
Wins Highest Award

The Charles A. Coffin Foundation Gold Medal, given annually to the company which has done most for the development of electric railway service, has been awarded for 1927 to the Virginia Electric and Power Company, W. E. Wood, President. This company is under the executive management of Stone & Webster, Inc.

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Volume 101 NEW YORK, DECEMBER 20, 1928 Number 25

A Christmas Greeting

ONCE a year the Christmas season enters into our lives to sweep away the daily monotony of practical affairs, even from the consciousness of the engineer. In this season each man, however aloof in his daily existence, comes to feel that he is neighbor and fellow to the world. The normal routine of life is put aside, and man's need and desire for closer kinship with others claim expression. Fittingly this opportunity comes in winter's darkest days, and prepares for a new year and a new spring.

With Christmas just ahead, the editors of *Engineering News-Record* count it a privilege to speak to their readers more intimately than at other times—as companions and friends. To each and all we wish the fullest happiness of useful endeavors and growing friendships.

The Pioneers

WE WORK today with the inestimable advantage of having at our command unprecedented resources in machines, materials and men. The engineer's equipment today is adequate for almost any task or undertaking, however great. It was quite otherwise with those pathfinders and pioneers who a century and more ago had to break the trail along which the civil engineering of the succeeding century was to make its progress. Engineers of today may profit by thinking back to the conditions and the difficulties under which those men labored, and by noting how their native genius enabled them to surmount prodigious obstacles. Brindley and his successors were in a sense the founders of present-day civilization, for they worked out the earliest stages in that advance toward a new era of transportation which wrought the modern revolution. The picture of their times and their doings which Dr. Lowe-Brown projects upon the pages of this week's issue is inspiring if read understandingly. True, it is history, but to the engineer it is living history, whose example and instruction are as significant and valuable today as generations ago. Let it be recalled that whatever we do is accomplished by the power of the inspiration derived from the deeds of past times.

A Better World

FROM time to time we read in statistics compiled by medical and public-health men that the span of human life has been lengthened quite a few years in recent decades, and apparently continues to lengthen. Pondering on such figures brings the interesting reflection that engineering work has been a principal agency in the improvement. It gave the adult protection against the formidable menace of diseases carried by water and flies, and by the same means, coupled with purification of the public milk supply, it brought about a remarkable reduction in infant mortality. These great works of human betterment have advanced the general wellbeing perhaps as much as all the labors of the doctors of medicine. While these achievements of engineers in the sanitary and public-health service were being wrought, other engineering activities produced a multiplication of the efficiency of human effort, through the creation of power and the invention of tools and machines for its application. As a result of these advances made by the engineer's art, we not only live more days but we accomplish vastly more in each day, so that the world has found time to push ahead beyond all dreams in its quest for the secrets of nature. A better world has been made, and whoever feels doubt of the worthiness of engineering work may find reassurance in this fact.

Quick Response

ENGINEERS can take a just satisfaction in the prompt passage of the Boulder dam bill by the United States Senate almost immediately after the report of the engineering board of review was laid before that body. The engineers had passed cogent and convincing judgment on the technical questions at issue; they left to the legislators the policy questions, as we pointed out last week. The Senate's action is a proper response to the board's work. It means that the legislators accepted and indorsed the findings of the engineers—their conclusion that there is no reason to entertain fears concerning the safety of the structure or the feasibility of the project—and therefore felt able to dispose of the policy questions without further misgivings. In doing so the Senate killed the demand for state power royalties, as well as the demand that power development be left to private interests except as a last resort. The action of the Senate represents one of the most significant steps in legislation for public development in many years. With the strong prospect that the House will promptly approve the Senate bill—having passed a slightly different bill last spring—the long-drawn-out case of the Colorado River conservation and development is going forward rapidly to its final stage.

Valuable Discussion

THERE is decided stimulation in the yearly gathering of men interested in road betterment which goes by the title of meeting of the Highway Research Board. The many-sided problems of the highway, problems measured in terms of billions of dollars each year, make it peculiarly important that the men who must solve them should verify and enliven their thinking through exchange of views with their colleagues. For this they have most excellent opportunity at the Highway Research Board meetings. But how fairly these gatherings are entitled to the use of the word "research" is less certain, since research work is by no means the most prominent or the most valuable element of the proceedings. May it not be that the often prosy character

of the sessions, the absence of discussion, and even the confusing and unwieldy committee presentation of loosely knit reports, are deficiencies chargeable to the name under which the work is done? Were the meetings held as sessions of a Highway Engineering Association, for example, it is possible that far more active discussion would develop, and more rapid clarification of road thinking would be achieved. The high ability of the several hundred men who assemble at the meetings, and their intense personal concern with all the complex factors of road problems, represent a potentiality which deserves to be utilized to the full.

State Control of Power

GREATER state control over power development, and particularly over the matter of interstate transmission of power, is favored by the Federal Power Commission in its annual report. In many instances federal agencies, notably the Interstate Commerce Commission, have withheld action upon matters coming within their jurisdiction until after the state body having local jurisdiction had reached its own decision. Under such conditions the federal body normally followed the finding of the state body. Where matters were of interstate nature, however, no such passing of responsibility for a ruling to the states most directly concerned was possible. But now the Power Commission expresses the belief that additional legislation might make it possible for the states to set up joint commissions to handle such local matters. Where the transmission of power across state lines is in question, the commission believes that final jurisdiction should rest with the state bodies concerned if the power is sold direct to customers by the company transmitting the power into the state, but that where the power is sold to a distributing company within the state, state court findings should be subject to federal court review, as the power under such circumstances is moving in interstate commerce alone. This idea of passing as much responsibility for local matters to state bodies as is possible has much to commend it. Local conditions affecting the case are not overlooked, the prestige of the state bodies is maintained and their responsibility increased and compromises are reached much more quickly, and usually on a more satisfactory basis than if the case had to go to a federal body for a ruling.

The Left Bank

THE LAW that gives to the county on the left bank of a stream jurisdiction over bridge franchises was brought into question recently in California in the application for a franchise to bridge San Francisco Bay. Supervisors of Alameda County were asked for authority to build a bridge from a bridgehead in that county to a western terminus in San Francisco, the basis for the application being that the northern part of Alameda County is on the left bank of the main waterway emptying into San Francisco Bay. Two streams flow into San Francisco Bay and unite in that body of water to pass through a common outlet, the Golden Gate, into the Pacific Ocean: The Sacramento-San Joaquin flow comes down through Suisun Bay past the northern end of Alameda County, which forms the left bank of that waterway; the long southern arm of San Francisco Bay that forms the San Francisco peninsula is the outlet of the second drainage basin, on whose left bank San Francisco County lies. As applied to the San Francisco Bay shoreline the designation of left bank is perhaps a technicality, since at least in the southern arm of the bay the tidewater moves practically without interference and the streamflow is a negligible quantity in comparison with the tidal flow; nevertheless there is no doubt as to what direction is downstream or which bank is on the left hand when one looks downstream. Since any bridge reaching San Francisco from the east shore must cross this waterway, San Francisco County will be on the left bank and under the law will have jurisdiction over franchises. Left and right bank are definite terms and leave no doubt as to the legislative intent. Under the circumstances the Alameda application is not likely to create a new precedent.

Concrete Dam Foundations

WHEN a massive concrete dam fails the chances are approximately eight out of nine (based on previous records) that the trouble originated beneath the structure itself. Foundation deficiencies of one sort or another to which such failures are ascribed usually may be more accurately described as failure of the builders to recognize and to carry out adequate treatment for the weaknesses of that particular foundation. Safe dams can be built on rather poor foundations: It is more important thoroughly to understand and adequately to treat minor foundation deficiencies than it is to build on better formation without adequate preparatory treatment.

To see the situation in a somewhat different light, suppose attention were to be allotted to the various elements of dam design in proportion to their relative importance in the safety of the structure as judged by the record of failures; on this basis it would be proper to spend about eight times as much time and money in analyzing, testing and studying foundation conditions as in working out stresses and preparing designs and plans for the structure itself. Fortunately, a comprehensive and exhaustive geological examination of a dam site can be made for a much lower percentage of cost. There is no excuse for slighting the question of foundation adequacy. It is highly inconsistent to go into meticulous detail in analyzing stresses, in working out ideal aggregate proportions and other design refinements pertaining to the structure proper, and then to build on a foundation about which much is taken for granted.

Dealing successfully with the foundation problem requires, first, the ability accurately to appraise the quality of the rock, more particularly its resistance to percolation and to absorption and the changes that would follow percolation or absorption; second, the equally important ability to prescribe and carry out adequate remedial treatment to make the structure amply safe and yet not unduly expensive. A practical knowledge of geology often is essential to meeting the first of these requirements and it is frequently helpful in the second.

Decisions must be made as to a sufficient depth of the main foundation, the proper location and depth of the cutoff, the nature and extent of grouting necessary and suitable locations for drains through and under the structure, not to mention the question of what uplift allowance is necessary. It seems obvious that in arriving at decisions affected by rock formations under an important dam, the engineer needs the advice of a geologist.

There should be no misconception about the responsibility carried by the chief engineer, no professional jealousy on his part and no hesitation about calling in

specialists to aid him. The development to high degree of specialties in many technical lines has but elevated the position of the civil engineer in responsible charge of a large project. His greatest service and his greatest success will result from co-ordinating the work of trained specialists. When he builds a great dam the foundation question becomes the first and foremost problem; the fact that he must take the responsibility entitles him to the advice and the opinions of the best specialists available.

Engineers in Contracting

THE introduction of the engineer into the construction industry has done much to produce the efficient contracting organization of today, accomplishing seemingly amazing results at a speed thought impossible a decade ago. Successful leaders of construction have always possessed strong inherent qualities: a knowledge of how to handle men and equipment, ingenuity to meet the expected and the unexpected, keen financial sense, perseverance that knows no limit, and an adventurous spirit which is ready to stake reputation and possessions on the ability to outwit the elements and the forces of nature. The older generation of contractors possessed these qualities to a remarkable degree, and their success, witnessed by the monuments of their works, commands admiration. Today, however, many engineers have shown that they possess these inherent characteristics, and they have been major factors in producing the modern super-contracting organization.

All successful contractors are not engineers, and obviously the vast majority of engineers have not the capabilities of a successful contractor. Yet it is that rare combination of engineering judgment and contracting sagacity that has done much to advance the construction industry to its present efficient state within a comparatively short time.

Contracting today is more than bidding and building. It is promoting, designing, financing, planning and, in rare cases, even operating, in addition to the primary functions of estimating and constructing. The contracting organizations of the past generation were virtually one-man companies—a shrewd leader with an intimate knowledge of every construction detail, and a few practical associates. The construction companies of today are complex organizations with an extensive array of technical, legal and business talent headed by able executives. In such organizations the engineer has a prominent place.

Bold departure from past practices is the contractor's daily lot. Foundations must go deeper than ever before, bridges of unprecedented span must be built, formerly unconquerable rivers must be dammed and controlled, and buildings must be erected with a speed and efficiency in keeping with the owners' ever-increasing demand for early completion. Every construction achievement presents new and different problems to the contractor. There are new methods to be devised and developed and new plant to build and operate. The problems arising on the job are of a nature to be better solved by men with engineering training as a background. Engineering alone cannot meet these exigencies. But a technical education coupled with that intrinsic construction ability equips the contractor to meet the modern demands of the industry to an extent hardly possible by the use of practical knowledge alone.

Accordingly, more and more are construction companies demanding that technical graduates alone be recruited to the operating ranks. Starting as timekeepers, material clerks, instrumentmen and even laborers, the engineering beginners are prepared for future positions as superintendents, construction engineers and managers. Many are weeded out in the process, some find their niche in the drafting rooms and cost departments, while others forge ahead to become leaders in modern construction organizations.

One official attributes the efficiency and construction speed attained by his organization to the increased use of technically trained men in construction operations. Such attitude is indicative of that which prevails within the industry. With greater construction programs ever before us, the engineer in contracting will do much to carry the industry forward to keep pace with the demands of the advancing age.

Compromise Resolutions

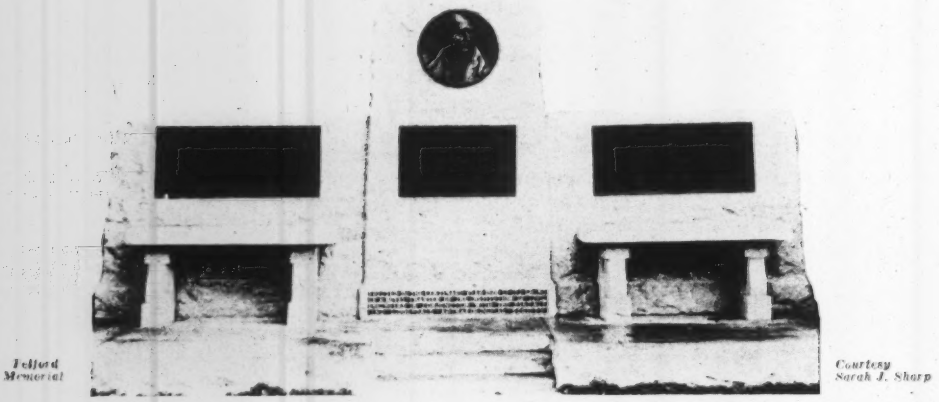
TO VOTE or not to vote, and if voting how to vote, and when the vote is counted what it really means, are questions incident to the letter ballot on cross-connections between safe and unsafe water supplies ordered sent to letter ballot by the luncheon-meeting of the New England Water Works Association on Dec. 12. The resolution has the usual weakness of compromises. It is subject to different interpretations by parties of opposing interests. It passes the buck to state health departments. Both in its "whereas" and in its second part is gives support to the advocates of double check-valves, which many engineers and sanitarians regard as a reed that may be broken. While the conclusions of the report do not indorse the new automatic chlorinator, the resolution opens the door to any claimant for its acceptance as capable of converting a non-potable into a safe supply.

In the face of a resolution so weak and so uncertain in its meaning when applied in practice those who consider balloting on the resolution will have three main courses open to them, each possibly supported in their minds by more than one reason: First, not to vote at all, because of indifference or uncertainty as to what the resolution means, especially when put to administrative test. Second, to vote for adoption because the compromise is satisfactory, or because any decision is better than no stand at all, or merely from a desire to support the committee. Third, to vote no, because the resolution is deemed too weak, or because it is thought too strong, or because no stand whatever is preferred. A ballot under such conditions will leave unknown the real feeling on cross-connections.

The committee is to be commended for its long-continued attempt to agree on a resolution acceptable to ten men with such a diversity of interests, but the members of the association would be in far better position to vote on cross-connections if, instead of attempting to compromise irreconcilable differences of opinion, it had frankly met the situation and submitted two or, if need be, three sets of resolutions for ballot, giving both extremes and perhaps a middle stand. The result of the ballot can have no binding force on any one, but if the diversity of opinion among members of the committee is representative of that among the membership, a ballot on two or three proposals would bring out that fact, whereas the present ballot can mean little. It will accomplish merely the acceptance or rejection of a compromise resolution, dissented from by two members of the committee and subject to doubt as to how heartily it is supported by the other.

Pioneers of Civil Engineering

Great Figures of One Hundred and Fifty Years of Civil Engineering Achievement in England



Telford Memorial

Courtesy Sarah J. Sharp

By W. L. Lowe-Brown
Consulting Engineer, London

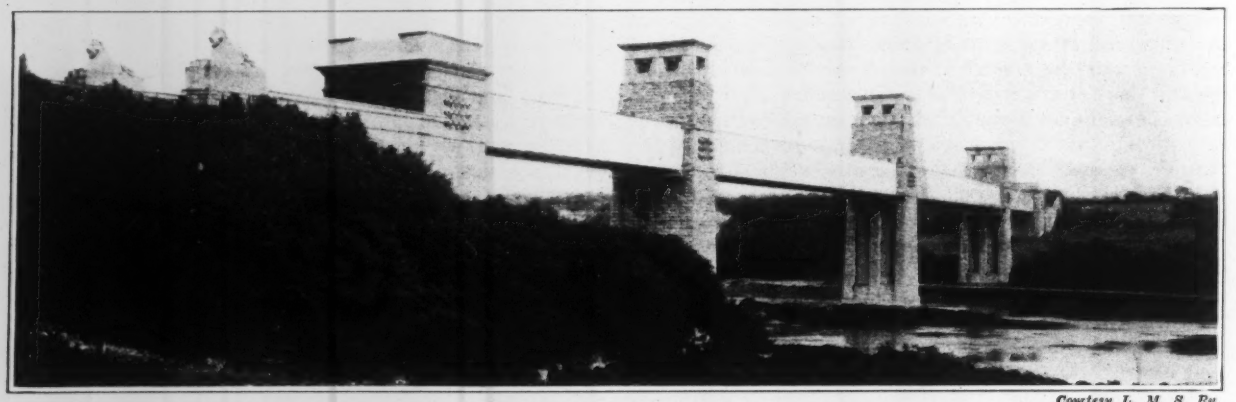
On AUG. 3 there was unveiled at Midnock, Westerkirk, Dumfriesshire, a granite memorial to Thomas Telford in the form of a pair of seats on a platform raised slightly above the roadway. On the central block there is a bronze medallion showing the head of the great engineer and an inscribed panel. Cut into the stone just below is the mark which was used by Telford when a working mason.

This memorial has been set upon a hill overlooking Megget Water and the Esk, quite close to the shepherd's cottage in which Telford was born. In the village of Westerkirk a handsome library had been erected and equipped out of the funds left for the purpose by Telford, but the local people felt that something even more prominent than this should be provided to mark the birthplace of so great a genius, and on their initiative and with the help of the Institution of Civil Engineers the necessary funds were soon collected.

Erection of this memorial calls to memory the simple life stories of the pioneers of engineering, full of human interest and an inspiration to accomplishment and self-reliance. They serve as a reminder of the fact that the successes of one generation are rendered possible only by the bountiful heritage it receives from those that went before, in difficulties overcome, methods perfected and in processes, machinery and materials discovered and improved. We learn that engineering must always progress; perfection is never reached. Each time a work is planned there is an opportunity to build it better than before. Works which the most ordinary engineer can now carry out as part of his every-day routine would have been impossibilities to the early masters, not because they were lacking in genius, courage or perseverance but because they possessed neither the materials nor the plant.

Industrial Beginnings and Inland Transport

Industrial development in England began with the invention of the steam engine by Watt; improvement followed improvement until in 1782 he produced the double-acting rotary beam engine. The steam engine, the basis on which the machinery trade has been built, gave an immense impetus to the coal and iron industry. At the same time other inventions such as Hargreaves' spinning jenny in 1767, Arkwright's spinning machine in 1768, Compton's mule in 1779 and Cartwright's power loom in 1784 transformed the textile trade in Lancashire, while Wedgwood's improvements in pottery stimulated the demand for the products of Staffordshire, with the result



Courtesy L. M. S. Ry.

BRITANNIA BRIDGE (1850)

that a wave of industrial prosperity spread over the country. This in turn made the development of inland transport an absolute necessity. It gave added impetus to the new canal industry, and canal building became the rage, accompanied by a fever of financial speculation.

Canals gave the first *and for three-quarters of a century the only* form of economical inland transport for heavy goods. Even later, when the advent of railways brought fierce competition, the canals more than held their own for certain classes of traffic, and they still serve a useful part in the transportation system today.

Brindley (1716-72), was the genius who first put canal engineering on a proper basis. He was the son of a cotter and as a millwright established a high local reputation, but it was not until 1756, when he was 40 years old, that he got his chance. At that time the Duke of Bridgewater was preparing to build the Worsley Canal. This canal differed materially from all built in England up to that date, which, following the general lines of rivers or streams, were river improvements more than canals. The Worsley Canal, however, was largely built through dry ground. Because of the many difficulties involved, the Duke sought the assistance of Brindley, who at once showed his mettle. At one point on the canal a double ladder of locks had been proposed where it crossed the valley at Barton, down one side of the valley and up the other. Brindley's first step was to insist upon the canal being carried level across the valley on an aqueduct, avoiding all locks. The project was looked upon as fantastic and was spoken of as Brindley's "castle-in-the-air," but it was a complete success and remained in constant operation until it had to be removed during the construction of the Manchester Ship Canal and replaced by a steel swing aqueduct.

ROBERT STEPHENSON, 1803-1859
From a print in the possession of the Institution of Civil Engineers.

Again when Brindley proposed the construction of the Harecastle tunnel, 1⅔ miles long, on the Grand Junction Canal, his scheme was proclaimed impossible. Once again he completely confounded the critics. The familiar story about "puddle it" is typical of the man and his way of doing work; he made up his mind how a job should be done and then stuck to it through thick and thin until it was finished, irrespective of criticism or difficulty. An appreciation written more than 50 years after his death says:

"Brindley, strong in his own powers, struck away at once into a new path and placed inland navigation by one gigantic stride so far in advance of the age that even in the present day the works of that time can almost afford to dispense with their date as an element in the appreciation of their merit."

The work thus begun was continued by Smeaton, Jessop, Rennie and Telford until, by the time that railways began to spread their network over the country, the principal industrial centers were already interconnected by a canal system that had a big hold upon the transport for the heavy industries. It may surprise many to learn that the Gloucester and Berkeley Canal, opened in 1827, was 86½ ft. wide and 18½ ft. deep, and would accommodate vessels of 800 tons.

Railways caused a setback to canal construction in England, but that triumph of de Lesseps, the Suez Canal, opened in 1869, with a bottom width of 72 ft. and depth of 26 ft., helped to keep canal construction before the public. When the Manchester Ship Canal, 120 ft. wide and 28 ft. deep, came to be constructed, the many complicated problems introduced by canal and railway crossings were ingeniously overcome, and, thanks to the general advance in engineering that had taken place, the work was probably no more arduous than the construction of a smaller canal would have been at an earlier date. The work was commenced in 1887 and completed in 1894. About the time that canals began to develop, the deficiencies of the roads began to be felt. Telford and Macadam are the most famous of a group of engineers who transformed the British roads from quagmires to highways. Telford drove roads into the highlands which brought whole regions within touch of the rest of the country; and into Wales the highway to Holyhead, which opened up a greatly improved route to Ireland. The making and remodeling of roads required also the building of new bridges or the rebuilding of old. Smeaton and Jessop (his pupil), Rennie and Telford built innumerable masonry bridges all over the country, and in their hands masonry bridge construction may be said to have reached its zenith.

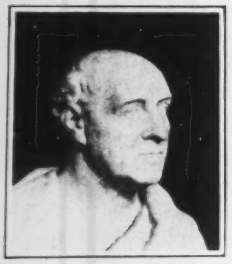
JAMES BRINDLEY, 1716-1772
From a print in the possession of the Institution of Civil Engineers.

About this time iron began to be used for bridge building. Cast iron was first used, to take the place of stone, and then wrought iron was tried. As wrought iron was chiefly valued for its tensile strength, it was not unnatural that the first bridges to be built of that material should be of the suspension type. The most noteworthy of these is the Menai Straits suspension bridge, 570 ft. in span, built by Telford on the great highway to Holyhead. This bridge, completed in 1826, is one of the landmarks in bridge engineering, and it still stands, although it has now become inadequate to present-day demands and will shortly be replaced.

Marine Problems

About this time ocean transport began to call for improved docks and harbors, and it was only natural that Smeaton, after his success with the Eddystone lighthouse, should be called upon to assist with harbor improvements. Ramsgate harbor is one example of his work which can be taken as a model of an artificial harbor, although on a very small scale. Rennie put dock construction upon a new footing by building three of the largest docks in London, adding greatly to those of

Liverpool and building docks at Leith and Hull. The successive inventions of Watt, Nasmyth, the two Stephensons and a long line of engineers, assisted by the accurate machine tools and standards of Whitworth, have produced the high efficiency of modern machinery and plant. Of the marine engineers we have another long line, headed in England by the younger Brunel, Maudslay and Fairbairn, continued by Laird and Armstrong and reaching to Parsons, who, breaking away in a different direction, produced a new machine which has created another era in marine engineering and made equally important changes in stationary plant.



THOMAS TELFORD, 1757-1834
From a bust in the house of the Institution of Civil Engineers

And now the internal-combustion engine, which has caused a revolution in road transport and made air travel a reality, bids fair to produce another complete transformation in marine engineering also. This wonderful progress could not have been made without the full cooperation of scientists to whom engineers owe an incalculable debt—to Black for the discovery of latent heat, to Kelvin for his interpretation of Carnot and Joule as well as for the formulation of the second law of thermodynamics, to Rankine for putting it into a form that could be used by all, to Froude for his work on ship resistance, and to hundreds of other workers.

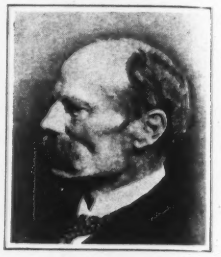
THE ELDER BRUNEL, 1769-1849
Mark Isambard Brunel, from a print in the possession of the Institution of Civil Engineers.

Bessemer gave us mild steel, which has entirely changed the economics of engineering. The enthusiasm with which his first discovery was received when published at the British Association meeting in 1856 was followed by bitter disillusion when the process on which such high hopes had been based failed to give the same results when tried elsewhere. Two years of patient work was required before he discovered the cause of the trouble (phosphorus) and the cure (manganese). The bessemer converter appeared in its present form in 1858, the first steel boiler was made in 1860, the first steel rails were laid in Crewe station in 1861. The specimens of steel shown at the 1862 International Exhibition excited the keenest interest. The first steel ship was built in 1864, and the same year the United States patents for bessemer steel were bought by an American syndicate. This discovery was followed by Siemens with the open-hearth process, the first successful plant being built at Crewe in 1868. Since then metallurgical discoveries have become so numerous that it is impossible to deal with them here, but the discoveries of Bessemer and Siemens (both English born) still remain the backbone of the steel industry.

The first steamer, built by Fulton, made her maiden voyage on the Hudson in 1807, but almost at once the British engineers began to attack the same problem. Bell's "Comet," built in Glasgow in 1811, was followed by the first iron steamer, built by Manby in 1820. Although several vessels with auxiliary steam power crossed the Atlantic as early as 1818 and 1819, no ship crossed under its own steam power unaided by sails until in 1838 the "Great Western," designed by Brunel the younger, crossed from Bristol to New York. In 1854 Brunel's "Great Eastern" was completed—693 ft. long and for many years the largest vessel in the world. The success of the "Great Western" was followed by the "Britannic" and three other ships ordered by Mr. Cunard in 1840, and from that time a competition which has continued up to the present moment has given us the huge greyhounds of today.

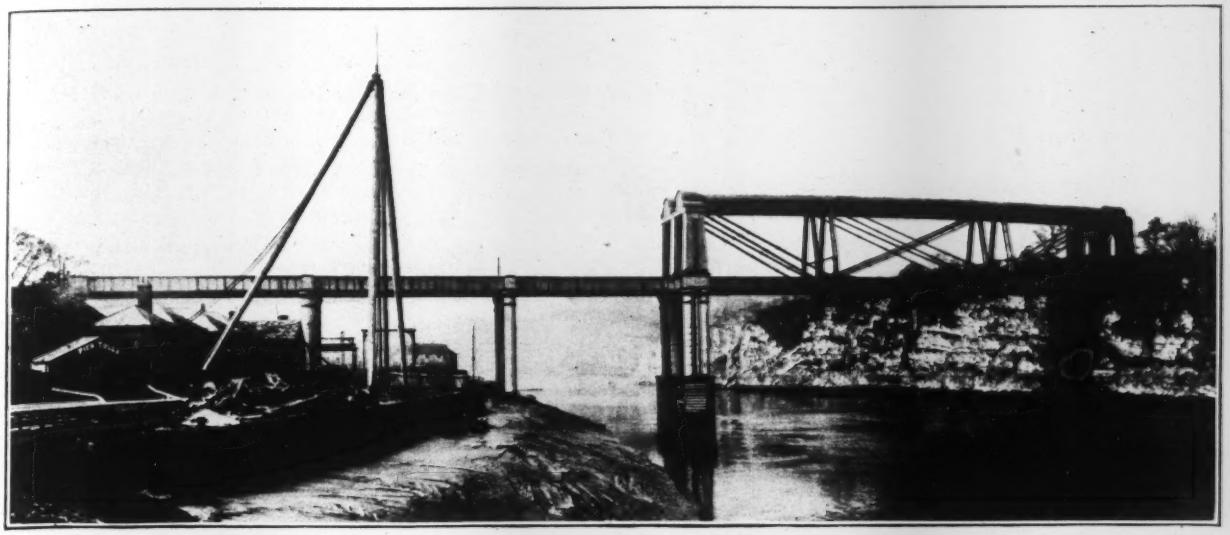
Railway Development

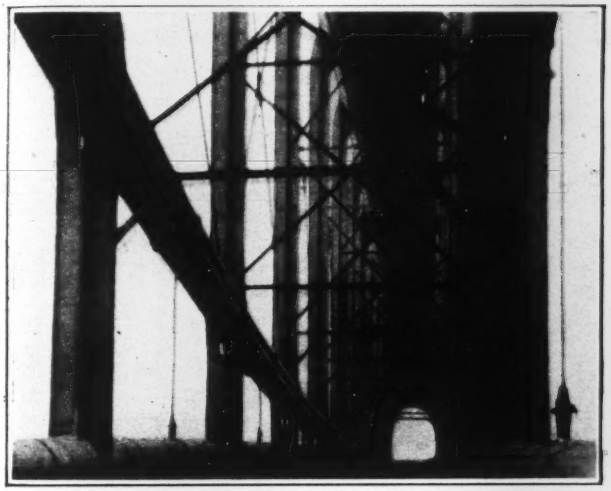
Railway development was next to claim the attention of engineers, commencing with the Stockton & Darlington line in 1825, but the first great advance was made with the construction of the Liverpool & Manchester Railway opened in 1830. This railway held a competition in 1829 at Rainhill to decide whether to adopt locomotives or stationary engines for tractive power. The "Rocket," with the first tubular boiler, attaining a maximum speed of 29 miles an hour, won the prize and astonished the world with its performance. Then the possibilities of railways began to be realized by the more imaginative and railway engineering burst into full bloom. The Stephensons, father and son, followed almost at once by the younger Brunel, Hawkshaw and others, built railways in every direction. Their works involved the solution of innumerable problems, any one of which would in normal times have been the sure foundation of an engineering reputation. It is hard to imagine designing and building a railway at the time the Liverpool & Manchester Railway was built with no standards of any kind. Even the gage was a matter of fancy; no one could tell whether it would be better to use rails of cast or wrought iron, or whether they should be supported upon stone blocks, longitudinal timbers or cross-sleepers; the form of joint had to be determined from experience; and estimates of the future development of the weight and size of rolling stock had to be made in deciding the loading to be taken in bridge design and the size and shape of structure-gage necessary, especially for bridges and tunnels. Signaling had not been invented but had to be devised. In addition, the engineers were the principal advisers in management and had to deal with subjects now considered outside their province. We find Robert Stephenson in his presidential address to the Institution of Civil Engineers discussing such questions as depreciation and renewal funds in a way that will stand the light of present-day accountancy. In spite of the immense amount of work and detail that, in the absence of contractors and of properly trained assistants, had to be attended to personally by the engineers, railways were built in all directions over river, marsh and mountain. Bridges were built, banks tipped, tunnels driven and enduring works of every description carried out which have stood the test of time.

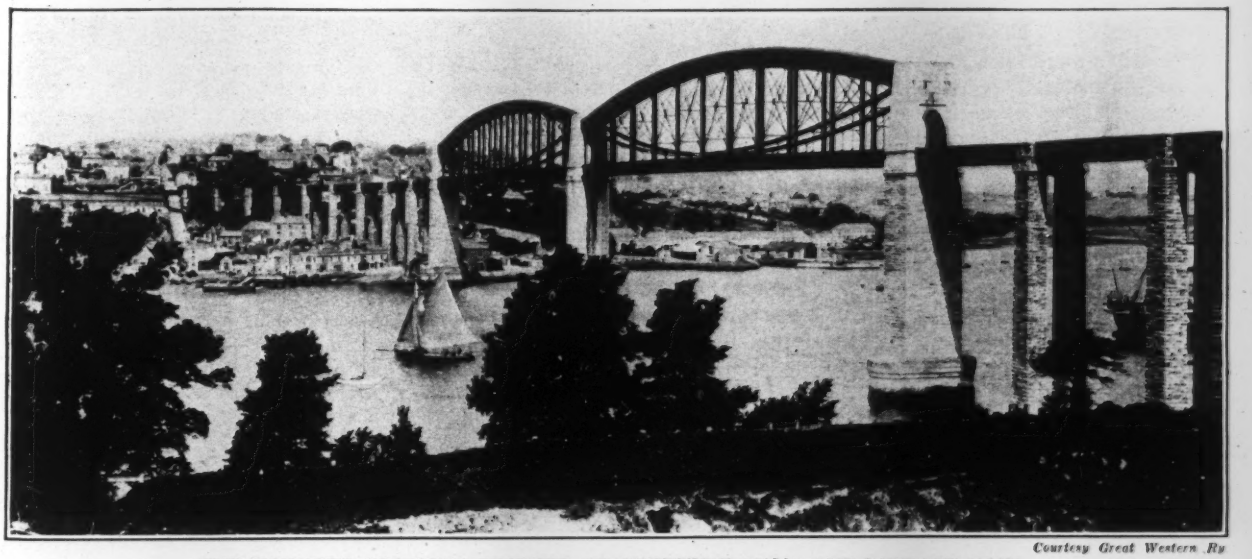


BENJAMIN BAKER, 1840-1907
Reproduced from the *Proceedings* of the Institution of Civil Engineers.

THOMAS HAWKSLEY, 1807-1893
Reproduced from the *Proceedings* of the Institution of Civil Engineers







Courtesy Great Western Ry

THE YOUNGER BRUNEL'S BRIDGES AT CHEPSTOW (1852) AND SALTASH (1859)

These remarkable structures, with single great tubular compression members, remain unique in the genius of their conception and execution. The earlier structure, at Chepstow (top and middle right), has straight horizontal top chord and uses trusses of Pratt web arrangement in two single-track bridges side by side. The Saltash bridge (bottom and middle left) is of lenticular form, with crossed diagonal rods in its web panels, and is single-track.

The work of these engineers was not confined to their own country, but extended to all parts of the world; monuments to their genius exist in Europe, North and South America, India, China, and all the British dominions and colonies.

New Bridge Builders

The Britannia tubular bridge of 460 ft. span, completed in 1848, with its companion at Conway, the work of Robert Stephenson with the assistance of Clark and Fairbairn, is one of the milestones in engineering progress. It is hard in these times of high-tension steel, powerful cranes and modern plant of all descriptions to appreciate fully the genius and courage of an engineer who would undertake to build a 460-ft. span for loads which in those days were considered enormous. The only possible material was wrought iron, but that material had hardly ever been used for railway bridge construction, and the strength of the material and the way of calculating the stresses were not properly understood. To build and fix, without any plant in the modern sense, four tubes each 470 ft. long and weighing 1,587 tons at a height of 100 ft. above the water in a site exposed to gales and without interfering with navigation was an engineering undertaking which calls for our highest admiration.

At the same time the younger Brunel was constructing the Great Western Railway, and his fertile brain was devising one ingenious work after another. The Saltash bridge over the River Tamar, opened in 1859, although somewhat shorter (two spans of 455 ft.), was perhaps more remarkable. This was a combination of suspension bridge and arch, the arch supporting a good proportion of the load, taking in compression the loads normally transmitted by the shore chains to the anchorages and at the same time stiffening the structure enormously. This bridge was a great advance over Brunel's first important iron bridge, at Chepstow, opened in 1852. In both bridges the compression member consists of a single tube above the track, to the sides of which the hangers supporting the deck are attached.

Soon after this mild steel became available, and from about 1865 onward practically all bridges were built of that material. The remarkable Eads bridge, at St. Louis with two spans of 502 ft. and one of 520 ft., was not opened until 1874, and the Brooklyn bridge, of 1,595½-ft. span, was not completed until ten years later.

The next landmark in bridge construction was the Forth bridge, designed by Sir Benjamin Baker. Years before in his published articles on long-span bridges he had shown the advantages of this type, and it may be said that he had in imagination built that bridge many times before he got an opportunity to demonstrate its advantages in practice. This was the first large-span cantilever bridge and was for many years the longest span in the world and may yet be considered as a model. Commenced in 1883, the work was finished in 1890. It consisted of two central spans of 1,710 ft. each, with a clear headway of 150 ft. and a floating span of 350 ft.; length of main portion 5,330 ft.; total length, including viaducts, 8,296 ft.

Courtesy L. N. E. Ry.

FORTH BRIDGE, COMPLETED BY BENJAMIN BAKER IN 1890

Baker was the first among British engineers to draw attention to the experiments of Fairbairn and Wöhler on the effects of repeated stress, a question which is nowadays buried in the simplicities of the Pencoyd formula and sometimes almost lost sight of except perhaps on the Pennsylvania Railroad, in the United States, where it still stood in that railroad's last bridge specification seen by the writer.

Driving Tunnels Through Rock and Under Rivers

Engineers who nowadays build shield-driven subaqueous tunnels with compressed air without difficulty through the worst of bad ground do not always realize what they owe to the great engineers of the past. It required no ordinary grit and determination on the part of the elder Brunel to keep struggling for seventeen

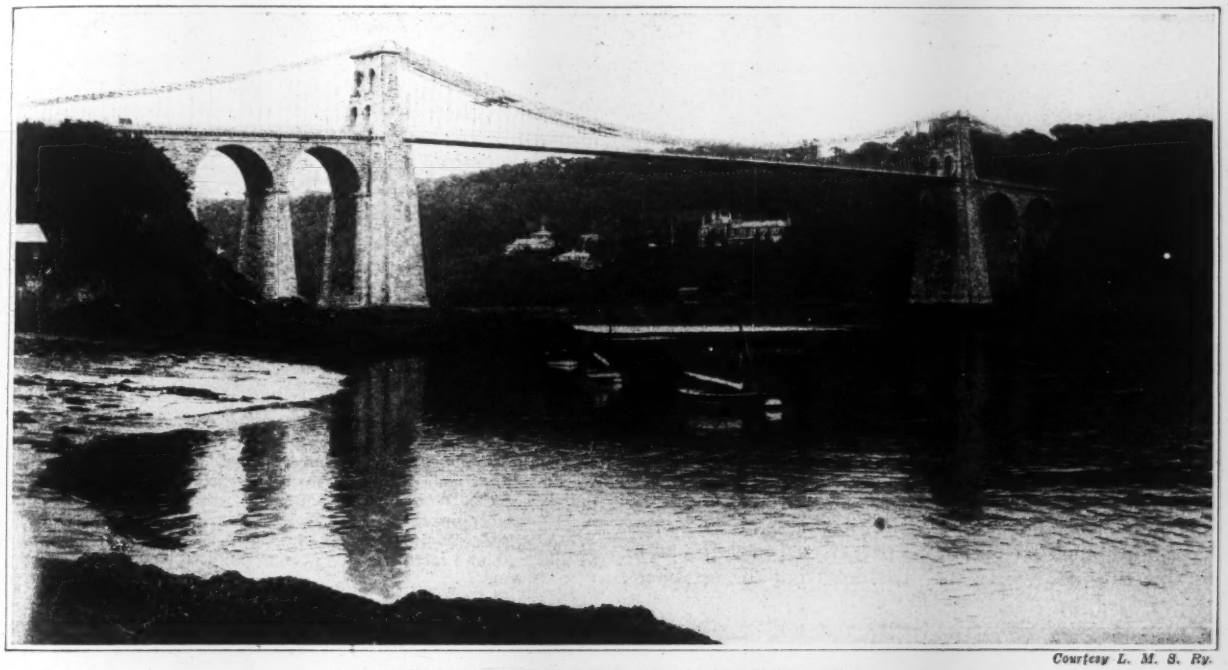
years (1825-42) in the construction of the Thames tunnel. Several times the river broke in and it looked as though he were defeated. A less tenacious man would have given up, but with dogged determination he persevered and triumphed. He was really ahead of the resources of engineering of his time, for his shield had most of the essentials of our present-day shield, but it could not be built like a modern one, because the materials and plant at that time had not been invented or devised.

Compressed air had been used by Smeaton with a diving bell for the repairs to the Hexham bridge in 1778, and Brunel used a diving bell in examining the riverbed when it had broken into the Thames tunnel, but compressed air had not yet been used for tunnel construction. Sir Thomas Cochrane patented the idea of using it for shaft and tunnel work in 1830, but no one used it. In France compressed air was first used in 1839 for sinking a small shaft. The first important work on which it was used, however, was in the foundations of the Rochester bridge in 1851. Still it was not employed in tunnel construction. Greathead had proposed to use compressed air for a tunnel in 1872, and finally in 1886 he made use of it in actual practice, when on the City & South London Railway he used the shield, compressed air and cast-iron lining in combination and in that way laid the foundation of modern subaqueous tunneling.

Haskin's Hudson tunnel, begun in 1877, was the first large tunnel started under compressed air, though without a shield. It was, however, before the times, and after getting into serious difficulties, both engineering and financial, had to wait for the perfection of the shield before it could be completed. But like all work where unforeseen difficulties have to be overcome, it gives opportunity for learning much from the study of its history, a most stimulating story of heroism on the part of all concerned.

Rock tunneling is more a matter of organization than engineering nowadays, with modern transport and modern drilling plant and modern explosives. It is hard now to realize the difficulties which Brindley overcame in 1766 when building the Harecastle tunnel, $1\frac{2}{3}$ miles long, with horse-gins for hoisting, windmills and waterwheels for pumping, and without compressed air drills, dynamite, electric light or proper transport.

No note of tunneling can be complete without a mention of one incident in the construction of the Severn tunnel, which is an example of the heroism and devotion of the workmen that has played a vital part in all these difficult enterprises. The tunnel had become flooded and work was suspended because the pumps could not lower the water level and it became evident that until a door in the bulkhead across the tunnel had been closed no progress could be made. Lambert, the diver, alone and with nothing but a novel and unfamiliar contrivance on his back containing a supply of compressed oxygen gas to feed his diver's helmet, went down the flooded shaft and walked 1,000 ft. underground in the flooded tunnel; he had to climb overturned skips, tools and lumps of rock, but at the second attempt he closed the door, thus enabling the water to be pumped out and the work continued.



Courtesy L. M. S. Ry.

SUSPENSION BRIDGE OVER MENAI STRAITS (1820)

Engineering Works in Other Fields

While engineers were busy developing means of transport and communication, equally able work was being done in water-supply, sewerage and lighting. Hawksley and another group of engineers provided every important town in Britain with a good water supply, good sewerage and gas supplies. Their work was so successful that they were called upon to provide similar facilities in all parts of the world, where they not only built important works but trained engineers of other nationalities who have been able to maintain and extend them as occasion demanded. For example, in Buenos Aires, Bateman designed and carried out an extensive water-supply and

drainage scheme, which has been maintained and greatly extended by Argentine engineers in a way which has fully upheld the high standard that was set by the original works.

In addition to municipal water-supply, irrigation works in India and Egypt which have conferred the greatest benefits upon the inhabitants have been carried out. Canals and dams have been built which are noteworthy illustrations of engineering achievement, as for example the Tansa, Periyar and Aswan dams. The Aswan dam, originated by Mr. (now Sir William) Willcocks, was eventually redesigned and carried out by Sir Benjamin Baker, who took entire responsibility for its construction.

The work itself was successful, but an unexpected danger arose soon after the dam was put into operation. The granite bed, which was looked upon as immovable, began to scour away in front of the sluices under the increased velocity. Baker faced the situation promptly but calmly, and under his guiding hand the problem was solved by the use of masonry aprons. Again later, when the demands for more water made it necessary, he devised an ingenious means by which the dam could be raised and its capacity doubled while maintaining its reputation as the strongest gravity dam in the world. The Aswan dam was the first structure of its kind where the whole flow of a great river in flood could be passed through undersluices when the river water was laden with silt and then when the appropriate time arrived the sluices could be closed down to reduce the flow of water past the dam while the reservoir was being filled.

The discoveries of Faraday and Hopkinson on which rest the foundation of electrical engineering are too well known to require detailing in an article of this nature and the vast strides which have taken place since would have astonished the discoverers; also wireless engineering, in which Lodge, Marconi, Fleming and de Forest have taken such an important part, is too new for us to be able to guess where they will lead, but the establishment of a regular wireless telephone between Amer a and England is a marvel we do not fully appreciate.

Genius From the Ranks

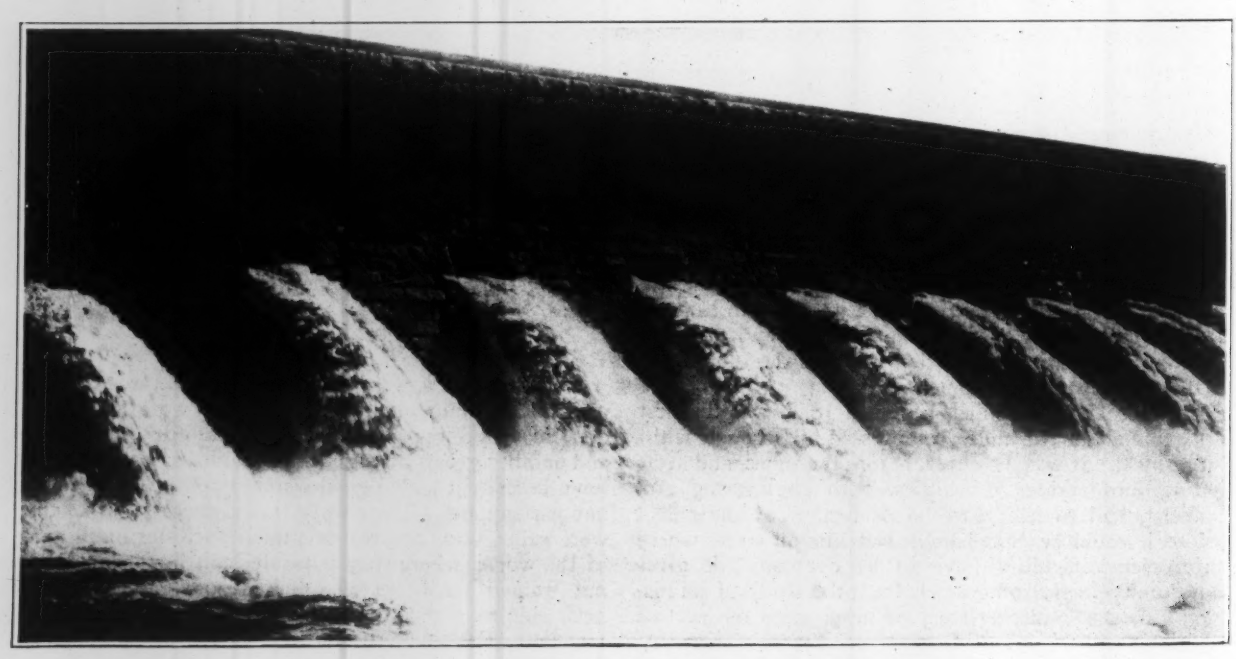
Now, who were the men who laid the foundation of modern engineering?

Brindley, Rennie and Fairbairn were millwrights. Telford, the son of a shepherd, started life as a stone mason. George Stephenson began as an engine attendant, and Smeaton and Watt as scientific instrument makers. Few of them had the opportunities of a scientific training. Neither Brindley nor George Stephenson received any early education in the ordinary sense, and the former was kept so busy with his work that he never learned to write properly.

How old were these men when they established their reputation as engineers? The younger Brunel took an important and active part in the construction of the Thames tunnel at the age of twenty and was only twenty-five when he won the prize for the design of the Clifton suspension bridge and thirty-two when his ship the "Great Western" first crossed the Atlantic. Robert Stephenson at the age of twenty was the managing partner of Robert Stephenson & Company, manufacturers of locomotives, and by the time he was thirty-five he had completed the construction of the London & Birmingham Railway, for which he was entirely responsible. He died in his 56th year, having built the backbone of the English railways and important railways in Canada, Belgium, Norway, Denmark, Switzerland, Tuscany, Egypt and India.

W. L. Lowe-Brown, the author of this article, was assistant engineer under Sir Benjamin Baker on the construction of 7 miles of parallel tubes for the Central London Railway; was assistant engineer and subsequently assistant division engineer under Sir Benjamin Baker on the Aswan reservoir and later director of works on that project; was resident engineer on the North River division of the Pennsylvania tunnel and terminal railroad at New York; was engineer of underground lines for the Buenos Aires Western Railway on the design and supervision of railroad tunnels at that port and later was engineer in chief of this railway.

—Editor.



ASWAN DAM, ANOTHER OF BAKER'S GREAT WORKS

Duplex Leaf Valve Designed to Operate Under Pressure

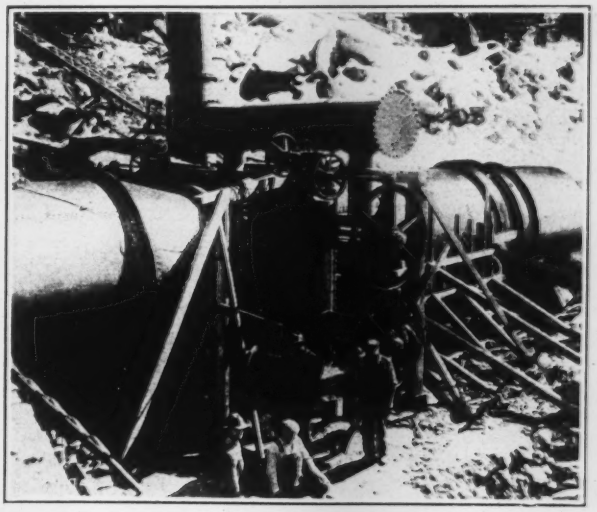
Making Closure With Two Leaves Instead of One Reduces Weight of Parts, Gives Rectangular Jet—Stems Are Horizontal

A MOTOR-OPERATED gate valve of novel design has recently been installed in the 10-ft. steel pipe line built by the Southern California Edison Company as an outlet from Huntington Lake to supply the Huntington-Shaver conduit. The valve has a capacity of 1,400 sec.-ft. and is designed to operate under a head of 60 ft. Its distinguishing feature is the use of two rectangular gate leaves in the same plane, operated by horizontal stems. This design gives smooth flow in practically all positions at the same time that it permits ready regulation of flow. These were the advantages that led to the adoption of a special design in place of the ordinary gate valve. Another advantage is that the arrangement materially reduces the size and weight of the mechanism and distributes the stress among four valve stems.

Water enters the conduit through an intake in the dam where a circular slide valve, 10 ft. in diameter, is provided for excluding water when the line has to be unwatered. This gate valve, designed for operation under equalized pressure, has a gate stem to hoisting mechanism on the top of the dam and a bypass for filling the short length of pipe between this valve and the duplex gate valve immediately downstream from the dam.

The duplex valve has a throat diameter of 8 ft. and is set at the downstream end of a reducer section 5 ft. long, whence it discharges into an increaser section, 14 ft. 4 in. long. These two tapered sections are attached to the valve proper by cast-steel flanges, $\frac{3}{4}$ to $\frac{7}{16}$ in. thick. The lower half of the increaser section is embedded in concrete.

The valve body is a casting made in two parts with a flanged joint on the vertical center line. Two rectangular leaves $8\frac{1}{2}$ ft. high by 4 ft. $2\frac{1}{2}$ in. wide and 14 in. thick constitute the inner parts of the valve. In operation they slide horizontally to and from bonnets formed in the castings of the valve, each half having a 48-in. travel.



DUPLEX VALVE IN PLACE BEFORE HOUSING WAS ERECTED

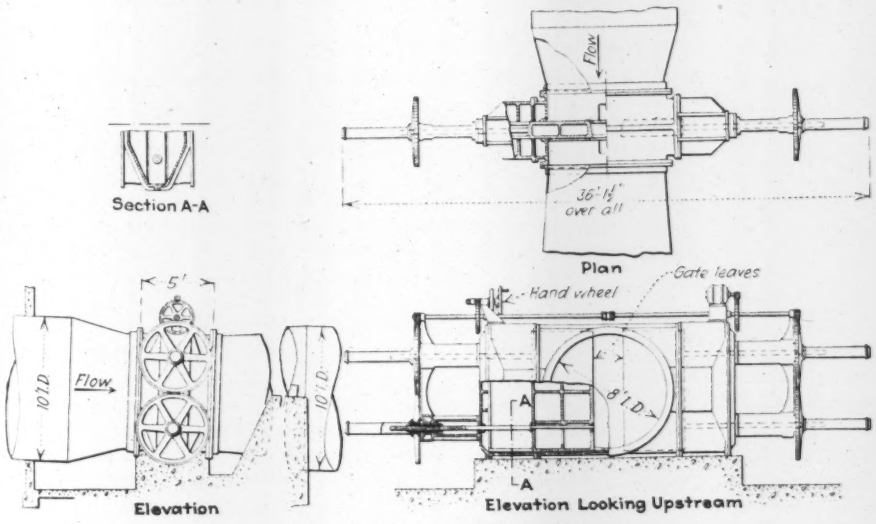
Closure is effected when edges of these leaves meet on the vertical center line. The leaves are iron castings weighing 8,000 lb. each; the vertical meeting edges are fitted with bronze seat strips.

The two leaves are interconnected so as to be operated simultaneously by a 10-hp. motor geared to a countershaft extending horizontally across the top of the valve. Each leaf has two $3\frac{1}{2}$-in. non-rotating stems that project through stuffing boxes in the bonnet covers. Bolted to the bonnet cover is a yoke for each stem, supporting the stem nut, ball thrust bearing and the nut driving gear. The upper stem nut gears on either side of the valve mesh with driving pinions on the countershaft. By means of a wheel and suitable gearing arranged for hand operation, the valve can be operated by hand when necessary.

A limit switch, gear driven from the countershaft, breaks the motor circuit when the leaves reach the open position and, on closing, the break is made when the leaves are within $\frac{1}{2}$ in. of closure, the actual seating of the valve being done by hand operation. Using the motor, the valve can be opened in nine minutes.

On the downstream half of the valve castings are two cored openings through which air is admitted from a standpipe on either side of the jet. This arrangement allows air to be drawn into the valve so as to prevent any tendency to the formation of vacuum on the downstream side. This is believed to be of material advantage in preventing pulsation, particularly at the smaller valve openings when a cross-section of the discharging jets is rectangular. The bypass around the valve is 14 in. in diameter.

As compared with the ordinary single-disk gate valve, the sizes of the stems, gears and thrust bearings in the duplex mechanism are reduced by the two-leaf, four-stem construction and the valve as a whole is symmetrical. The valve itself,



DETAILS OF 8-FT. DUPLEX VALVE

the mechanism and the tapering pipe sections are supported on concrete foundations and the entire assembly is housed because of the heavy snows that occur at this location.

Design of this mechanism was worked out by the engineering staff of the Southern California Edison Company, H. L. Doolittle, chief designing engineer.

River and Harbor Work on the Great Lakes

RIVER and harbor work on the Great Lakes involves an expenditure of about $5,000,000 for the current year. The tonnage for the calender year 1927 was upward of 140,000,000 with an estimated value of $2,000,000,000. Passenger traffic at Detroit amounted to about 18,000,000. The Lakes division comprises five engineer districts with a total of more than 80 improvements. The work now in progress or contemplated in the immediate future is briefly described as follows:

At Sandusky, Ohio, contract work of deepening the dock channel to 22 ft., about 280,000 cu.yd. of ledge rock and overlying material, at an estimated cost of more than $1,000,000.

In the Middle Neebish (upbound) channel, St. Marys River, Michigan, contract for dredging about 1,343,000 cu.yd. of material in Course 5 at an estimated cost of more than $180,000. Contract for removing about 700,000 cu.yd. of rock and about 950,000 cu.yd. of other material from Course 6 at an estimated total cost of about $2,400,000. Contract for dredging about 834,000 cu.yd. of material from Course 7 at an estimated cost of more than $200,000. Work of removing about 120,000 cu.yd. of rock and 35,000 cu.yd. of other material from Course 9 will soon be advertised. The work in Courses 5, 6, 7 and 9 will materially widen the upbound channel—from 300 to 500 ft. to a depth of 22 ft. Course 8 has ample depth and will require practically no work for the 500-ft. width.

At Green Bay, Wis., contract dredging, involving about $290,000, is in progress to deepen the outer channel to 21 ft.

In addition, contract dredging has been done this year in Chicago River, Indiana Harbor Canal, Calumet River and at Buffalo Harbor, and, by government dredges, at many other harbors on the Great Lakes. At the Milwaukee U. S. caisson plant 60 concrete caissons were built during the year (at about $3,500 each) for use in constructing breakwaters at Milwaukee, Frankfort and Muskegon harbors. New breakwater work at these localities is especially extensive and important, the Milwaukee breakwater alone involving about 5,600 lin.ft., in two contracts, at an estimated cost of more than $1,000,000, exclusive of the cost of caissons, which are furnished by the United States. The Muskegon breakwater involves about 3,200 lin.ft., contract cost more than $400,000, exclusive of caissons furnished by the United States. At Frankfort about 2,600 lin.ft. of breakwater is under construction at a contract cost of about $340,000, exclusive of caissons (furnished by the United States).

Maintenance repair of breakwaters and piers was carried on during the year by government plant and consisted generally in replacing timber superstructures with concrete. Work of this character was done at Oswego, Black Rock Canal (Buffalo), Chicago harbor, Kewaunee, Wis., Manistee and Ludington, Mich., Olcott, N. Y., and at various other localities. This work is progressive, and the general plan is gradually to replace all pile or crib structures by superstructures of concrete.

Col. E. H. Schulz, Corps of Engineers, division engineer, has recently inspected the more important works on the Great Lakes and reports great interest in these improvements. A comprehensive report prepared by a board of engineer officers has recently been made on the Great Lakes and connecting channels, and has been forwarded to Congress by the Chief of Engineers, through the Secretary of War, recommending a 23-ft. project (which means 23 ft. actual draft for vessels) at lake datums, at an estimated cost of $24,000,000. This report will no doubt be acted upon soon by Congress.

The various local officers in charge of the Lakes work are: Major R. S. Thomas, Buffalo; Major D. M. Coach, Detroit; Major Jasper W. Bagley, Lake Survey, Detroit; Lieut.-Col. W. C. Weeks, Chicago; Lieut.-Col. John J. Kingman, Milwaukee, and Major P. S. Bullard, Duluth.

Traffic Control Adjacent to Safety Zones

Abstract of a committee report by Leslie Sorenson, traffic engineer, Chicago, presented to the National Highway Traffic Association at its New York meeting, Dec. 10, 11 and 12. This is presented as supplementing the comment on this subject given by Mr. DeBerard in an article on how traffic congestion is fostered by traffic control published in our issue of Dec. 13, p. 883.

THE construction of a safety zone should in all possible cases provide a slightly raised area, 4 ft. wide and extending a few feet more than the length of the longest car to use that zone or the length required for two such cars if a double loading berth is to be used. The near side of this zone should be 30 or 32 in. from the gage line of the rail, depending on the width of the car.

That end of the zone from which street traffic approaches should be adequately protected by a bumper which will prevent automobiles from driving lengthwise on to the safety zone. This bumper should be of a type which will stop an automobile or deflect it sidewise without causing it to stop instantaneously, as it would do if striking very heavy pipes set vertically in the pavement across the end of the zone. The less abrupt stop will lessen the injury to careless drivers and yet protect the zone.

The end of the zone should be thoroughly illuminated by floodlighting and by two yellow flashing lights which are set at about the height of the tail light of an automobile and pointed directly toward on-coming traffic. At least a part of the safety zone should also be thoroughly illuminated by floodlighting.

Parking and Loading Restrictions—Alongside the curb opposite a safety zone and for a distance of at least 25 ft. beyond the end of the safety zone parking must be prohibited. Temporary stopping for loading or unloading must also be prohibited in this section, except during the period when traffic is held by a red light at the intersection immediately adjacent. This is fundamentally necessary in order that traffic may, when permitted by traffic signals, move continuously between the safety zone and the curb while a street car is standing to load or unload in the safety zone.

Car Track Driving—The Chicago ordinance permits driving to the left of safety zones unless by so doing it would unnecessarily delay the stopping of street cars at the regular stopping place. It is unlawful to drive to the left by raised safety zones at any time unless the road is barricaded.

Pittsburgh is now contemplating an ordinance which would permit driving to the left of safety zones unless a vehicle or street car is stopped in such space or unless a traffic control device shows the go indication. The model city ordinance of the National Conference on Street and Highway Safety permits driving to the left.

The only object to be accomplished by prohibiting driving to the left of a safety zone would be to avoid unnecessary interference to the street cars that are following. Due to the overwhelming number of persons traveling by street car compared with those riding in the other vehicles it is important that street cars be permitted to move into the loading and unloading position with the minimum of interference. If the drivers of other vehicles use reasonable discretion in driving through to the left of a safety zone only when they can do so without being stopped, then the operation of the street cars will not be interfered with but will in fact be speeded up, because the other traffic on the street will have an additional lane in which to move when the street cars are not using that lane. All traffic will, therefore, be given improved operating conditions if the track space can be used by vehicles when street cars are not present to use it, or when such use will not hold street cars out of their loading space and cause them to make a second stop after the space alongside the safety zone has cleared.

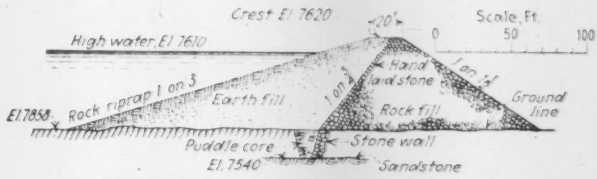
Earth Dam Temporarily Repaired After Partial Washout

AFTER the partial washout of the 63-ft. Pleasant Valley earth dam of the Price River Conservation District, in Utah, May 21, 1928 (reported in *Engineering News-Record* on May 24, p. 827, and May 31, p. 872), temporary repairs were carried out to the point of sealing the leaks and permitting the reservoir to be drawn down gradually. This repair work, however, has not yet progressed far enough to make the dam permanently secure. Extensive further operations will have to be undertaken in the immediate future, according to a statement of the situation by George M. Bacon, state engineer of Utah.

Construction of the Pleasant Valley dam was described in our issue of May 31, 1928, pp. 864-866. It is of the earth- and rock-filled type with an unusual distribution of material (see illustration). The rear portion is a rockfill with a downstream slope of 1 on 1½ and an upstream slope of 1 on ¾. Against this is placed the earthfill, the upstream side of which has a slope of 1 on 3, paved with 12 in. of riprap. The dam has a maximum height of 63 ft. above streambed and 78 ft. above bedrock, with a top width of 20 ft. The steep upper slope of the rockfill is faced with large rock forming an inclined wall which varies from 6 ft. thick at the base to 2 ft. at the top. All material rests directly on the surface with the exception of a cutoff wall the entire width of the site, made up of a 6-ft. rock wall and an adjoining puddle core.

Emergency repairs carried out at the time of the leakage and partial washout consisted in partly filling the caved portion of the upstream half with sacks of sand and scraping in other material without any particular care as to its deposition. After the immediate danger was over, a representative committee of local interests was appointed by the Governor of Utah, which underwrote and looked after further repairs. This committee had "full power to decide what to do to remove the existing danger to life and property and to carry out the program that it might decide upon."

Availing itself of the services of the State Road Commission, this committee proceeded to complete the filling of the caved portion of the dam by scraping in additional



CROSS-SECTION OF PLEASANT VALLEY DAM

material and leveling off the top of the dam to an elevation about 7 ft. below its original height. It also excavated the spillway to an additional depth of 10 ft. and lined it with a wooden flume. By these measures a safe discharge capacity of about 500 sec.-ft. was obtained. The committee also retained a board of engineers, whose names were suggested by the Engineering Council of Utah, to review the general situation and make recommendations as to what other work should be done.

After examining the conditions and studying all the evidence, the board reported that the accident was due to shrinkage cracks caused by the drying out of the material of the dam, the washing out of fine material of the earthfill or upstream part through the rockfill portion and subsequent caving in of the earth above. It recommended that hay which had been placed in the dam during emergency filling be removed and replaced by earth filling of selected material and that the spillway be enlarged to a capacity of 3,600 sec.-ft. The outlet tunnel around the south end of the dam, whose downstream portion had developed serious defects while water was being drawn off, was to be repaired thoroughly by replacing the floor. This floor had buckled badly, and at the lower end had failed entirely and been washed out. It was evident that considerable water had come from the reservoir and was leaking into the tunnel under pressure at many places. The board recommended three sets of collars between the gate house (near mid-length of the tunnel) and the outlet, and grouting of the tunnel around the top and side walls.

At present the water in the reservoir is down practically to the level of the floor of the outlet tunnel, and a new floor is being placed in the discharge end. The Price River Conservation District, which owns the dam, is unfortunately in serious financial difficulty; it is practically out of funds and the necessary money can be raised only by assessment. For the present, therefore, work must be limited to what is absolutely necessary to put the outlet tunnel in thoroughly satisfactory and safe condition. By proper control of the discharge, the reservoir can be kept from filling next season and yet store sufficient water to take care of irrigation needs. It is believed that the cultivated land can be taken care of with 20,000 acre-ft. storage, whereas the capacity of the reservoir filled to the height reached last spring is about 62,000 acre-ft.

Annual Meeting of Highway Research Board

Traffic and Operating Subjects Receive Major Attention—Pennsylvania Tests of Cable Guard Rail Finally Reported—A Study of Machine Mixing of Concrete—New Data on Tire and Wind Resistance—Bond Issues or Pay-as-You-Go Financing Contrasted

LIKE its predecessors, the eighth annual meeting of the Highway Research Board, held in Washington last week, ranged over a broad variety of subjects, concerned with financing, design, construction, operation and maintenance of roads, and some matters relating solely to road vehicles. There was rather less reporting of investigational work than the title of the organization would indicate, and in particular distinctly less on the experimental study of road structure than in some previous years. Much attention was given to traffic and operating questions, on the other hand. Despite the current active interest in all major road questions, little or no discussion followed the reading of the committee reports and papers; however, this has come to be more or less characteristic of the board's meetings.

Reports of three experimental investigations were prominent. In one of these, H. S. Mattimore, of the Pennsylvania Highway Department, dealt with the tests of cable guard-rails carried out by that department some years ago, and the guard design evolved through these tests. In another, Prof. A. N. Talbot, of the University of Illinois, reported in very brief outline an elaborate study of machine mixing of concrete. In the third, Prof. E. H. Lockwood, of Yale University, gave new data on wind resistance of automobiles. The two reports first mentioned will be reported more fully in future issues.

Cable Guard Rail Tests—For danger points on roads, Pennsylvania practice had developed two-rope safety railings made of discarded ¾-in. mine cable strung through holes in wooden posts and anchored by deadmen. Such railings were tested by running a truck against them at various speeds up to more than 30 miles per hour, and the behavior of the elements of the structure was studied. It was found that a 1-in. upper cable and a ¾-in. lower cable, securely anchored to reinforced-concrete deadmen, were necessary; and that in order to avoid hub contact in glancing collisions the rope should be set out several inches from the posts by blocking. The railing so built safely stopped a truck even in severe impact.

Concrete Mixer Operation—At the request of the Koehring Company, Professor Talbot made extensive tests of mixers a year ago, using two sizes of mixer, 21- and 27-ft. The test included regular batches, over-batches and under-batches; rich and lean mixtures; wet and dry mixtures; various sands and coarse aggregates; cement distributed over aggregates or bunched; water put in first, last or distributed, sprinkled on or added in a full stream. As to mixer construction, there were variations in arrangement of blading, different speeds and different conditions of cleanness. It was found that the arrangement of blading had an important bearing on the effectiveness of cross-mixing; that too high speeds caused the materials to flow from the blades in streams, with less effective mixing action; that overloading the mixers tended to reduce the effectiveness; that roughness on the mixer surfaces delayed the mixing, so that a clean condition of the mixer is important; and that a factor of safety on mixing time is desirable.

In discussion, A. H. Myer, testing engineer of the Iowa Highway Commission, described studies of water-measuring devices recently completed, in which the errors in measurement were determined. Very large errors were found in some cases, due to "leakage" or the amount of water passing direct from inlet to outlet pipe of the measuring tank when both valves were open. He concluded that present methods of water measurement on paving mixers are too inaccurate for desirable uniformity of concrete and that weight measurement, though difficult, may be worth considering. A. A. Levison, of the Blaw-Knox Company, remarked that a study of truck mixers similar to that carried out by Professor Talbot is desirable and that in all mixer tests the effect of water in the sand should be studied by using the inundator. He expressed the opinion that wet sand assists in scouring the mixer and brings about a shorter mixing time.

Air Resistance of Automobiles—Coasting tests were conducted by Prof. E. H. Lockwood, of Yale University, on two long uniform gradients, down which the cars tested were run at various initial speeds until the equilibrium speed was determined. Rolling resistance was subsequently measured in separate tests in the laboratory. The road speeds were 40 to 60 m.p.h. The rolling resistance, on balloon tires, ranged from 11.6 lb. per 1,000 lb. at 10 m.p.h. to 16 lb. at 60 m.p.h. The coefficient of air resistance of sedan models (in the formula $p = 0.0001\,kV^2$, for pounds per square foot and miles per hour) averaged 16.6, which agrees with model tests made in Germany and is smaller than results found in Kansas and Iowa tests. Open cars showed coefficients 2 to 3 units higher with top up, and still higher with top down. In general, these air resistance results checked with empirical conclusions of automobile designers, who to make their calculated maximum speeds agree with road test results were led to fix the air-resistance coefficient at 20 to 21.

Traffic and Safety Studies

Road Traffic—J. Gordon McKay, director Cleveland Highway Research Bureau, summarized briefly certain findings obtained in road and street traffic studies in Cleveland and vicinity. Most important was the fact that even in so densely developed and active a county as Cuyahoga the road traffic is mostly local, only 2½ per cent of road traffic entering at one end of the county passing out at the other; that heavy traffic is restricted to metropolitan regional areas, and that outside of such regions there is little necessity for more than two lanes within fifteen years. The traffic measurements also indicated that rural roads in general carry so light a traffic that their earning power is insufficient to pay for any costly improvement and the social subsidy theory may have to be drawn upon.

An airplane photographic survey of the main road between Washington and Baltimore, made a year ago, was briefly described by Dean A. N. Johnson, of Maryland State College. From these photographs it was possible to compute values of road capacity per hour as related

to speed, noting vehicle spacing and speed (the latter determined from the overlap observations). From these observations the maximum capacity of one traffic lane was indicated as more than 3,000 per hour, if a continuous traffic file could be maintained. Actual road counts, however, have never shown more than about 1,200 per hour, checking Dr. McKay's observations. The difference represents the effect of the separation of traffic into cuts or blocks.

Traffic Analysis—Reporting for the committee on highway traffic analysis, G. E. Hamlin, superintendent of maintenance of the Connecticut Highway Department, recommended that highway authorities be authorized to establish building setback lines to preserve right-of-way; that storage facilities be provided off the highway in order to make the whole trafficway available for fluid traffic; that six-wheel trucks with pneumatic tires are desirable and should be encouraged by suitable legislation; that metropolitan regional highway systems should be placed under a single jurisdiction for planning, constructing and financing; and that a standard form of accident report be developed. He also recommended as subjects for research the capacity of four-lane roads variously arranged and two independent two-lane roads; and the traffic density at intersections which justifies grade separation.

Safety—R. Stoeckel, motor vehicle commissioner of Connecticut, presented reflections on unsafe cars, which he traced mostly to sale by junk dealers. He recommended the novel plan of a higher license fee for cars more than three years old unless certified as safe on special examination.

Beyond the matter of guard railing, already mentioned, safety features of the road structure or equipment received little mention. The personal factor was discussed by S. J. Williams, of the National Safety Council, who reported the beginning of an elaborate classification study designed to localize causes of highway accidents. "Repeaters" will also be studied. A brief discussion brought to the fore two principles: (1) Practice caution and courtesy, and (2) put the best tires on the front wheels.

A series of accident figures presented by the Pennsylvania Highway Department showed that the relative hazard is highest in the months of least traffic and lowest in the months of heaviest traffic; is lowest on Sundays; is highest from 2 to 3 a.m., when traffic is least; is higher on improved rural roads than on unimproved roads; is nearly nine times as great on short curves as on tangents, and on heavy grades five times as great as on light grades; and several times higher on rural roads than on urban streets.

Highway Economics

Prof. T. R. Agg, of Iowa State College, reporting for the committee on highway economics, said that air resistance is taking on a new importance because of high speeds. Many bus lines now have schedules requiring 50 m.p.h. on the open road. Hence rolling resistance is relatively much less important. He also reported a continuous decrease in the cost of operation per vehicle-mile during the past five years, and during the past year some operating costs as low as 3c. per vehicle-mile.

The operating savings due to changing a low type to an intermediate type of surface he placed at ¾c. to 1c. per mile; due to change from intermediate to high type, ¾c. to 1¼c. Packed snow increases the cost ½c. to 1½c., bus figures being near the maximum. Attempts to segregate costs have not yet been very successful. This subject was discussed more extensively by H. E. Phelps. A new tire-testing machine was described by H. B. Shaw and James Fontaine, of North Carolina State College.

Financing Road Work—For the committee on highway finance, H. J. Kirk, director of highways of Ohio, reported the methods used in several states to promote the passage of bond issues.

An interesting contrast of views was presented by T. H. Cutler, chief engineer of the Missouri Highway Commission, speaking in favor of bond issues, and J. T. Donaghey, former chief engineer of the Wisconsin Commission, on financing from current funds. The former, as also A. B. Gray, of West Virginia, emphasized the importance of resorting to bonds in the case of a primitive highway system where a large amount of road must be built in a short time to develop any earning capacity. Mr. Donaghey brought out the economy of saving interest payments and building in proportion to the earning power of the system.

Pavement Slab Action

A mathematical analysis of dowel spacing on centerline joints was reported by Prof. H. M. Westergaard, of the University of Illinois. Assuming the two halves of the slab in close contact, the load at the edge of one, calculation of the deflection curves of both loaded and unloaded halves enables the load transfer by the dowels to be computed. He found that dowels spaced 2 ft. reduce the bending moment 25 per cent, while larger spacing makes the value of the dowel disappear. He also pointed out, from mathematical analysis, that as the slab breaks up into smaller units, the wheel-load stresses do not decrease, so that uniform slab thickness seems advisable.

In brief contributions by L. W. Teller, of the U. S. Bureau of Public Roads, and A. T. Goldbeck, of the National Crushed Stone Association, the factors affecting the length change of pavement slabs were discussed. With 100 deg. temperature variation the total length change increased by 50 per cent as a margin, indicating expansion-joint width of $1\frac{7}{8}$ in. for a 100-ft. slab, and $\frac{3}{8}$ in. for a 20-ft. slab. An attempt was also made to calculate the conditions controlling cracking, with the conclusion that reinforcement is of little service.

C. A. Hogentogler, of the U. S. Bureau of Public Roads, presented some observations on test roads purporting to show the relation of slab cracking to dry and wet condition of subgrade, to reinforcement and to richness of mix. He found that reinforcement has no marked effect on dry subgrade but does have an effect on wet subgrade, though in this case percentage of reinforcement did not appear to be a factor. He professed to be unable to explain the improvement due to reinforcing, and ascribed it to some unknown change in the properties of concrete. He also stated that in a number of instances a harmful effect of wet subgrade on the quality of the pavement appeared to occur. Further research in this field is necessary, he remarked.

The necessity of further investigation was also brought out with respect to wheel-load distribution and amount of impact, in a discussion by Prof. E. B. Smith, of Iowa State College.

Tests made by Samuel Eckels, chief engineer of the Pennsylvania Highway Department, gave some data on the distribution of wheel load across the width of a tire. The tests were made with spring scales under separate

2½-in. widths of the tire. It was found that about half the total load was carried on the middle segment, the adjacent segments carrying each about half as much.

Maintenance—L. S. Trainor, of the Portland Cement Association, summarized the present knowledge of maintenance of concrete pavement. Thorough curing is vital to durability; early maintenance is equally important. In repairs of cracks or spalled joints it is important to remove embedded material before refilling. In patching broken areas with concrete, they should be cut square rather than have any re-entrant or acute angles, and the faces should be trimmed vertical for at least 2 or 3 in. down from the top. Where minimum interruption of traffic is important, high-early-strength cement may be used to advantage.

Bituminous Roads—G. H. Henderson, chief engineer of the Rhode Island Highway Commission, described penetration construction in his state; he gave the maintenance cost at $125 to $150 per mile per year. Improved results in smoothness obtained both by machine and by hand finishing were discussed by C. N. Conner, who said that the use of mechanical finishing will increase, though coarse or some sticky mixtures are better hand finished. W. J. Emmons, materials engineer of the Michigan Highway Department, dealt *in extenso* with bituminous materials for surface treatment, discussing separately requirements for clay, sand, loam and gravel roads.

Fine-Aggregate Concrete—C. N. Conner, engineer executive of the American Road Builders' Association, in a separate paper described the practice of several states in making road concrete with sand and with natural gravel, lacking coarse aggregate. Successful service has been obtained from these roads. R. W. Crum, director of the Highway Research Board, said that Iowa has obtained results from such concrete as good as that from conventional concrete, though the mixing probably is slower.

Maintenance Equipment—G. C. Dillman, state highway engineer of Michigan, reporting for the committee on maintenance, outlined the work accomplished during the past year by highway organizations to standardize the cutting edges of blade graders. This standardization fixes length in entire feet from 6 to 9 ft., and bolt spacing at 12 in. except for a 3-in. end space and 3-in. space from last hole to end of blade. This standardization is already going into practice. Committees of the American Association of State Highway Officials and the American Road Builders' Association are planning to co-operate in standardizing methods of purchasing equipment.

Fills in Peat Marshes—An interesting addition to an earlier paper which described Michigan experiences in the settlement of fills over peat marshes was made by V. R. Burton and A. C. Benkelman, of the Michigan Highway Department. In marsh depths of more than 25 or 26 ft. the fill in nearly every case broke through the peat layer. Generally the material of the fill does not move laterally beyond the toe of the fill, but recently in some cases very extensive spreading of the fill material was found. A case of serious settlement during service was described, showing the importance of obtaining full penetration of the fill material through the unstable strata. In this case, where the road must be widened, the location will be abandoned and a location partly on firm ground and partly on a relatively short and shallow marsh crossing will be adopted. The trouble zone in peat marsh crossings lies between 7 to 25 ft. peat depth, which is too deep for excavation of the peat and too shallow to assure penetration of the fill material.

Wheel Spacing and Axle Loads of Ladles Mounted on Standard-Gage Trucks

THREE ladles for transporting molten metal from the blast furnaces of the American Rolling Mill Company at Hamilton, Ohio, to the open-hearth department

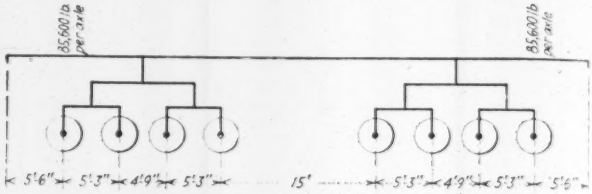


FIG. 1—WHEEL SPACING OF LADLE CAR

of the East Works of the same company at Middletown, Ohio, a distance of approximately 11 miles, recently were put into service. They were described in our issue of July 12, 1928, p. 78.

The ladle car has a total weight of 306 gross tons when loaded, but by providing a double-truck lorry for the

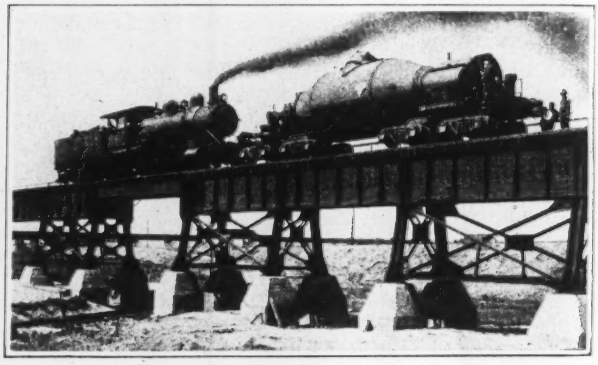


FIG. 2—306-TON MOLTEN METAL CAR

support of each end of the ladle, axle loads have been kept down to 85,600 lb. The wheel spacing is as shown in the accompanying drawing.

Federal Funds Aid Highway Construction

During the fiscal year of 1928 government funds through the federal-aid act were utilized on a total of 10,198 miles of highway, of which 8,184 had not previously been developed with U. S. funds, according to the annual report of Thomas H. MacDonald, chief of the Bureau of Public Roads. The total cost of the 8,184 miles of initial construction was $205,053,784, of which the federal government paid 43 per cent and the states the remainder. The largest disbursements during the year were made to the states of Illinois, Iowa, Kansas, New York, Pennsylvania and Texas, each of which received more than $3,000,000.

Opposition to the construction of private toll bridges, long an attitude of the bureau, was reiterated in the report and the hope expressed that "the use of federal-aid funds in payment of a part of the cost of important bridges would be continued."

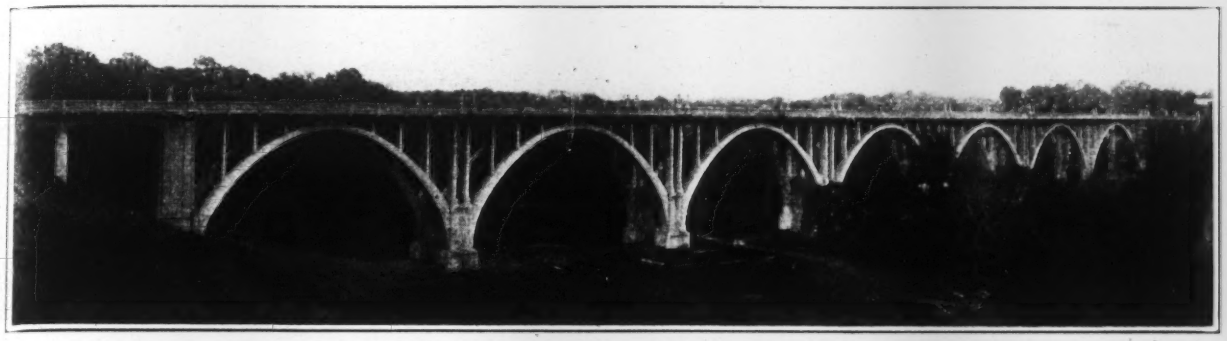


FIG. 1—NEW VIADUCT AT ASHTABULA, OHIO
Arches are flanked on the east (left) by two and on the west by four arched deck-girder spans.

Features of an Open-Spandrel Arch Viaduct

Design Studies Make Important Contribution to Knowledge of Behavior of Monolithic Arch and Deck—Unusually Comprehensive Expansion System—Construction Procedure

By J. R. Burkey

Chief Engineer of Bridges, Department of Highways, State of Ohio, Columbus, Ohio

A CONCRETE open-spandrel arch-type viaduct of unusual interest was recently completed by the Ohio State Department of Highways. Located on the Chicago-Buffalo road, U. S. Route 20, it provides a high-level crossing of the Ashtabula River valley at Ashtabula, Ohio, and opens a new direct route for this important highway avoiding the congested area of the city. The general situation is shown in Fig. 2. Unique features of design and construction were employed, and studies of the complex behavior of the monolithic arch and deck are believed to constitute work of a pioneer nature in this field.

In developing plans for the structure, the following objectives were kept in mind: An expansion system that would function efficiently without injury to contact parts; a rigid control of construction joints, particularly those which would be horizontal; a means of avoiding unsightly sags or deviations in deck alignment; and the adaptation of these objectives in such a manner as to obtain a pleasing appearance for the structure as a whole, with due regard to the problems of the builder.

Description of Structure—Since shale exists at a shallow depth below ground level throughout the length of the structure, open-spandrel arches were adopted across the valley, with continuous, arched deck-girder spans at each end. There are seven arch spans (Fig. 1), each having a length of 135 ft. between pier centers flanked by six equal girder spans—four on the west and two on the east end, each having a clear span of 39 ft. 3 in. The most westerly span provides a separation of grades with Main St. (Fig. 4).

The viaduct has a descending grade of 0.4 per cent toward the east. All arch spans are made exactly alike above the springing lines, the height of the pedestal piers being varied to accommodate the change of grade and the variation in the elevation of the shale foundation. Two ribs are used with a clear span of 121 ft. and a rise of 60 ft. from spring to intrados at the crown. Each rib is 6 ft. wide and has a thickness of 3 ft. at the crown. A typical arch span is shown in Fig. 3.

The roadway is 32 ft. wide between curbs with a 5½-ft. sidewalk on either side. For the possible future use of the bridge by street cars, the floors slab is provided with a central trough 8 ft. wide which is filled with a lean granulated slag concrete to facilitate easy removal. This is indicated on Fig. 3.

The railing and lampposts are made of granite-chip concrete. Forms for these were stripped while the concrete was green, and the surface mortar was immediately scrubbed off, leaving a uniform rough texture which is pleasing in appearance, not subject to crazing and uninviting to defacement. The railing and posts were cast in place, being separated at both ends of each panel by a $\frac{1}{8}$-in. coating of melted paraffine. At all expansion joints there is a 1-in. open joint in the railing.

Expansion System—Each span is separated from the adjacent spans by a butt-end expansion joint in the deck over the center of each pier. The spandrel columns, and particularly those over the piers, have an unusual slenderness which permits them to yield during expansion or contraction of the deck. A spandrel wall in the panel at the crown anchors the deck longitudinally and, assuming the deck anchored at this point, each spandrel column

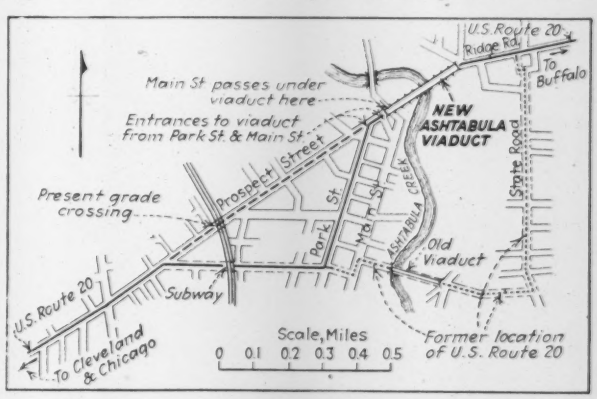
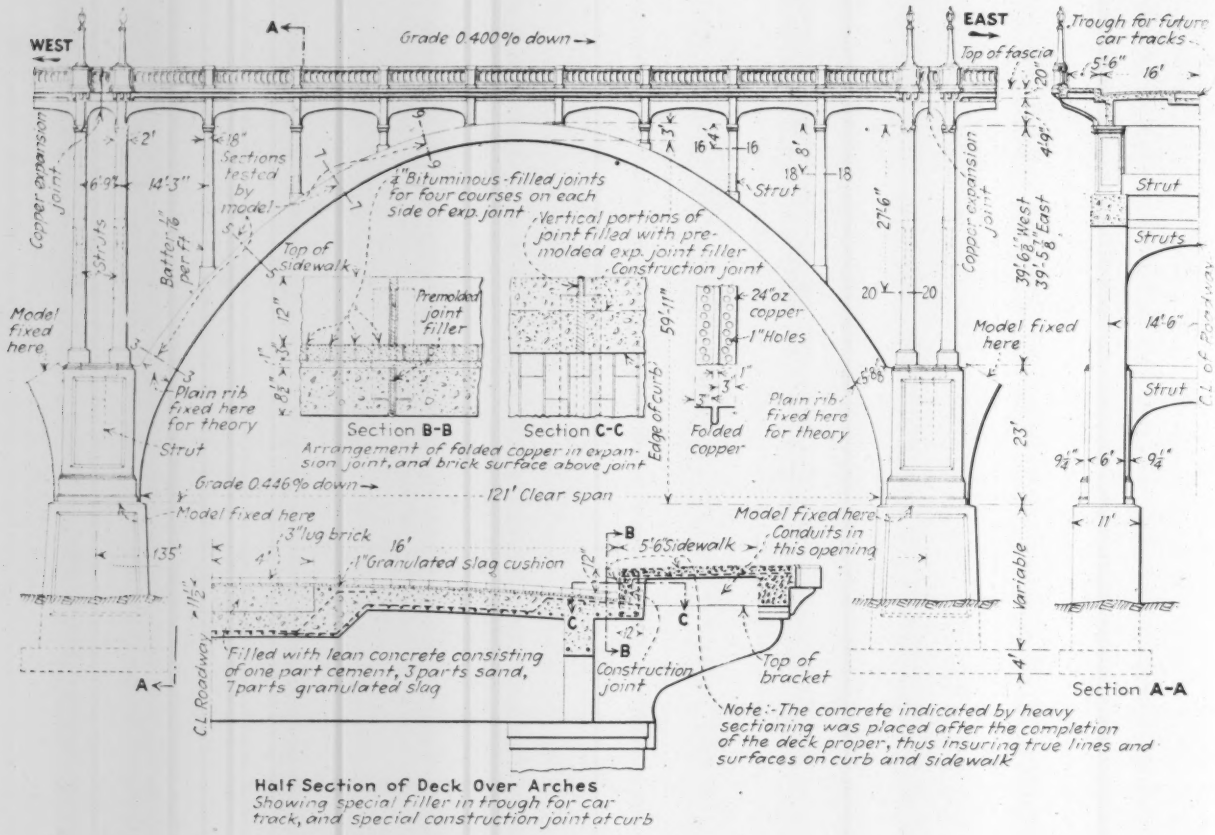


FIG. 2—RELOCATION OF U. S. ROUTE 20 MADE POSSIBLE BY NEW VIADUCT

was designed to accommodate the total deck movement between the column and the center of the span. These columns were assumed as fixed at the top and bottom.

The same type of expansion joint was used for the girder spans, flexible column supports being provided in front of the abutments, simulating pilasters. Because of the shortness of these columns they could not accommodate the movements due to temperature if they were fixed at the bottom, hence pockets 4 in. deep were provided in the footings in which was placed a 3-in. bed of sand, upon which, with an intervening piece of sheet iron the columns were cast. This arrangement, which afford


WEST
EAST
Grade 0.400% down →
Trough for future car tracks
Top of fascia
Copper expansion joint
Struts
Batter 1" per ft
Sections tested by model
1" Bituminous-filled joints for four courses on each side of exp. joint
Vertical portions of joint filled with pre-molded exp. joint filler
Construction joint
Top of sidewalk
Premolded joint filler
24 oz copper
1" Holes
Model fixed here
Plain rib fixed here for theory
Strut
Section B-B
Section C-C
Arrangement of folded copper in expansion joint, and brick surface above joint
Edge of curb
Folded copper
Grade 0.446% down →
121' Clear span
Model fixed here
3" lug brick
1" Granulated slag cushion
5'6" Sidewalk
Conduits in this opening
Filled with lean concrete consisting of one part cement, 3 parts sand, 7 parts granulated slag
C.L. Roadway
Construction joint
Top of bracket
Variable
Section A-A
Note:-The concrete indicated by heavy sectioning was placed after the completion of the deck proper, thus insuring true lines and surfaces on curb and sidewalk

Half Section of Deck Over Arches
Showing special filler in trough for car track, and special construction joint at curb

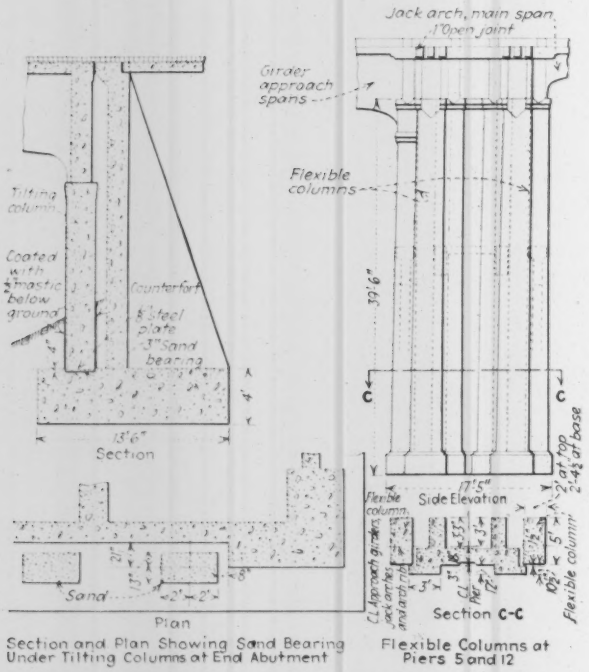


FIG. 3—DETAILS OF ASHTABULA OPEN-SPANDREL CONCRETE ARCH VIADUCT

approximately a pin-end condition at the bottom of these short columns, is shown in Fig. 3. At the east abutment the bottom of these columns extends below ground level, hence this portion is given a ½-in. coat of bituminous material to permit movement when the ground is frozen.

At piers 5 and 12 (the ends of the arch spans) for architectural reasons it was desired to provide a somewhat massive appearance of the piers. Pier shafts at these points support the deck immediately over them, but detached flexible columns support the adjacent deck of the girder and arch spans respectively, as shown in Fig. 3. On account of cramped conditions these columns were difficult to construct, but the arrangement seemed worth while to carry out the general scheme of butt-end expansion joints throughout the entire structure.

The expansion joints in the roadway and sidewalk slabs are provided with U-shaped copper sheets to retain the asphalt used in the joint and to prevent leakage through the floor. The pavement is 3-in. lug brick with asphalt filler on a granulated slab cushion and over each expansion joint for eight courses of brick ¼-in. separators were used between courses so that extra space would be available for bituminous material. Fabric waterproofing was used on the roadway slab.

Curb Alignment—To permit a correction for any settlement or displacement of forms during construction, it was specified that the roadway, sidewalk brackets and

FIG. 4—ARCHED DECK-GIRDER APPROACH SPAN, ASHTABULA VIADUCT
Columns supporting girders at left are cast on sand bed. This particular span carries the viaduct over Main St.

the rear portion of each curb beam were to be constructed in advance of the sidewalk and face of curb. This involved an unusual construction joint in the curb beams, which is illustrated in enlarged detail in Fig. 3. In this manner it was possible to hold the forms for the curb face and fascia in their correct position. The contractor appreciated this and was particularly careful, with the result that unusually true lines were obtained in this conspicuous part of the structure. A generous number of dowels were used to tie the curb face to the slab and rear portion of the curb beam. The curbs extend 12 in. above the finished brick pavement as a protection to the motorist, pedestrian and sidewalk.

Construction Procedure—Construction was carried on with strict adherence to the plans. The contractor planned his operations thoughtfully and in co-operation with the engineers in charge of construction. Timber falsework was used throughout, and by an ingenious arrangement the lower portion of the falsework was used as a trestle upon which a locomotive crane operated on the center line of the structure at an elevation just above the top of the pier umbrellas, as shown in Fig. 5. This crane handled all heavy timbers and forms, backing away from the upper falsework and forms as construction progressed. Light form materials and reinforcing steel for the deck were brought in directly over the deck construction. Inserts anchored to the bottom of the floor were used as supports in dismantling forms and falsework. Concrete materials were delivered by light truck to a mixer located on the deck. The mixer was not operated on the concrete until it had sufficient age to withstand the vibration without injury.

The ribs were placed in five sections. Symmetrical end sections followed by a crown section were placed on one day, using radial bulkheads provided with keys. The intervening sections on either side of the crown were placed symmetrically on the following day. The location of these sections was predetermined in design and care was taken to provide a lap of the main reinforcing steel in the closing sections to prevent initial stress in this steel. A worth-while feature was incorporated in the design of the ribs whereby the extrados steel was grouped in two symmetrical bands toward the outer edges of the rib, leaving a 15-in. opening along the center line of the rib. This permitted access to the ribs by inspectors and workmen.

Horizontal construction joints were avoided wherever possible. They were used at the top of footings, the top of umbrellas and at the base and top of all columns. Between these points none was permitted. Columns 40 ft. high were placed without interruption other than what resulted designedly from placing several of them simultaneously to promote settlement of concrete and relieve pressure on the forms. The writer believes that too much emphasis cannot be placed on avoidance of horizontal construction joints, particularly in members which are so thin that laitance may escape removal on account of inaccessibility.

An excellent quality of slag concrete was obtained throughout the work. Aside from the granite-chip concrete in the railing there were but two mixtures of concrete used in the structure: 1:6½ in the footings and 1:5½ in other parts. Standard cylinders were tested during the work with the results shown in the accompanying table.

CONCRETE CYLINDER TESTS

	Age in Days	Number of Tests	Average Slump, In.	Average Strength, Lb. Per Sq. In.
1 : 5½ mix	7	73	4 0	2,835
	14	47	4 2	3,537
	28	94	4 0	4,507
1 : 6½ mix	7	11	2 4	1,998
	14	12	3 1	2,804
	28	13	2 4	3,818

The specifications for concrete required that there be not less than one sack of cement to the nominal number of cubic feet of aggregates (measured separately) in the respective mixtures, with the further requirement of a minimum cement content per cubic yard of concrete. The amount of water was to be kept at a minimum consistent with necessary workability. Failure to obtain a specified average strength was to be corrected by adjusting aggregates and if necessary increasing the cement. As the specified average strength at 28 days was 3,000 lb. for 1:5½ concrete and 2,700 lb. for 1:6½ concrete, it is evident that the results were considerably in excess of requirements in so far as strength is concerned.

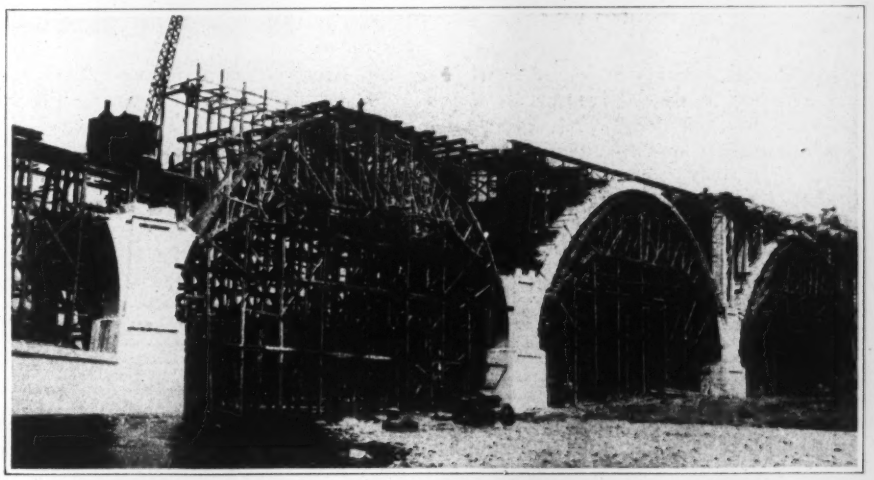


FIG. 5—TIMBER FALSEWORK SERVING AS TRESTLE FOR ERECTING CRANE, ASHTABULA VIADUCT

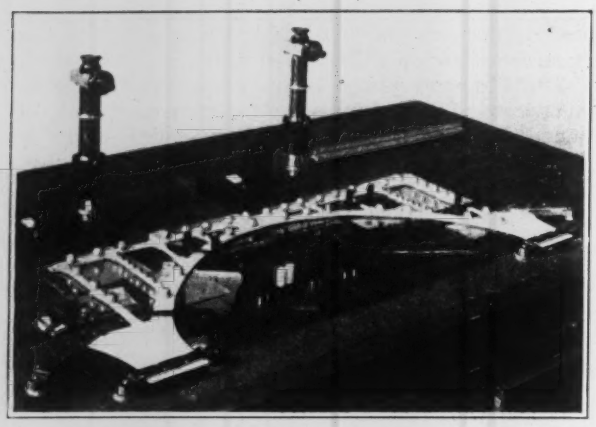


FIG. 6—MODEL OF ARCH SPAN USED IN STRESS ANALYSIS
Note deformeter gages attached to the arch ribs in panels 1 and 3. Other deformeter gages are attached to the spandrel columns near the far end of the model. The small weights hold the model in position on the glass plate. The micrometer microscopes measure the displacement.

Model Studies—With the conviction that the presence of a deck acting monolithically with an arch rib substantially affects the stresses in the rib, it was decided to study this relationship by observations upon a model of the structure. The analysis of this arch acting monolithically with the deck was made by D. H. Overman, designing engineer of bridges of the Ohio Department of Highways, in the fall of 1925, and is believed to have been one of the first solutions of this particular problem, although Adolph Buhler, bridge engineer for the National Swiss Railways, Bern, Switzerland, was completing a similar analysis at that time. Although the design of the structure was actually made on the theory of complete independence of the arch rib and the deck, the analysis on a basis of monolithic construction was of such importance that it is given here.

The mechanical method which was used for this analysis was that devised by Prof. George E. Beggs, of Princeton University. Briefly, the method consists of measuring related displacements of a model cut from celluloid or a fine quality cardboard. The model is of constant thickness, with the members given the same proportions of stiffness as those for the actual structure. This is accomplished by making the widths of the model members proportional to the cube roots of the moments of inertia of the cross-sections of the corresponding members in the actual structure. Fig. 6 shows the cardboard model which was used for this analysis with deformeter gages attached to the arch rib at sections 3 and 7 and to the spandrel columns at sections 16 and 20. Additional sections tested are shown on the arch detail of Fig. 3. Since the model had to be cut at the center of each gage, it was necessary to splice these points before subsequent tests could be made at other sections. In order to minimize friction, the model and gages were supported upon horizontal glass plates by means of steel bearing balls. The small weights which may be seen in Fig. 6 are in no sense applied loads but serve only to hold the cardboard in a true plane. No actual loads were applied to the model, the method being based entirely upon relative deflections. The two micrometer microscopes were used for measuring the displacements of a series of small celluloid targets which were glued to the model along the center of gravity of the deck. The displacement of each target was measured each time a predetermined thrust, moment or shear displacement was produced in the model by one of the gages.

By applying Maxwell's theorem of reciprocal deflections to the observed displacements and corresponding gage displacements, influence lines were obtained for thrust, moment and shear for each of the sections tested. After obtaining the influence lines for all sections with the floor system in place, the deck and spandrel columns were cut from the arch rib and new influence lines were then obtained in the same manner for the bare rib, except that the targets were on the center of gravity of the rib instead of the floor system.

The influence lines which were obtained by model for thrust, moment and shear at section 9, near the crown, are shown in Fig. 7, together with the theoretical curves for the same section. In the case of the bare rib, the differences between the influence lines by theory and model are probably due to the theoretical values being based upon fixed conditions at the ends of the rib, whereas the model was fixed near the springing lines of the adjacent arches and also at horizontal planes located at the top of the pier pedestals, thereby permitting some distortion in the piers. In this connection it is probable that the actual conditions of fixity are more nearly represented by the model than by the theoretical assumptions.

The influence lines for section 9 and likewise for all other sections clearly show that the presence of the deck materially decreases the maximum intensities produced by partial loading. On the other hand, for full loading they indicate that the deck has little effect upon the intensity of stress at any section. Thus we have proof that the deck acting in conjunction with the arch rib functions in a manner similar to a stiffening truss and provides a much greater factor of safety for the arch ribs than is considered available when the ribs are analyzed by the elastic theory.

Influence lines for direct stress in the end three columns at sections 16, 18 and 20 are shown in Fig. 8. No appreciable moment or shearing stresses could be detected in these columns at the sections tested except

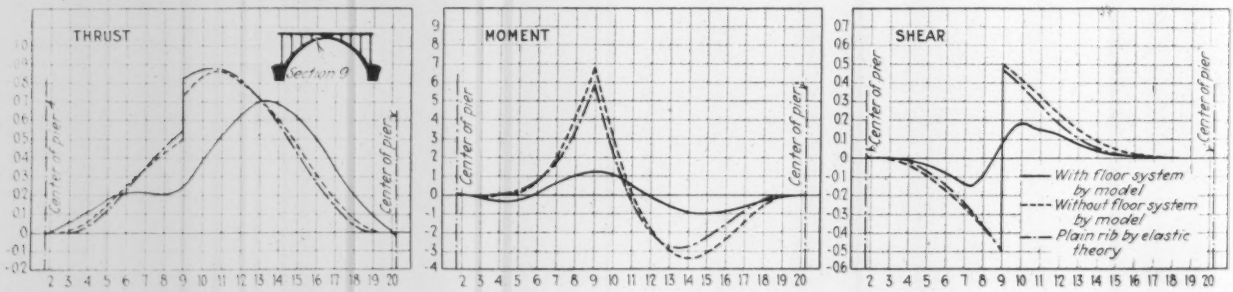


FIG. 7—INFLUENCE LINE FOR THRUST, MOMENT AND SHEAR AT SECTION THROUGH ARCH RIB
Note that influence lines are given for the structure both with and without the floor system as determined by model and for the ribs as determined by the elastic theory.

near in the shorter column at section 16. Referring to these influence lines, it is interesting to note that only 5 per cent of a load over column 16 is transmitted directly to the column; while for columns 18 and 20 47 per cent and 100 per cent of a superimposed load are borne by the respective columns. The trend of the variation seems logical, but the wide range in values is quite surprising. It is obvious that a system of equal loads applied simultaneously at all columns would be much more equally distributed to the columns. This is borne out by a summation of the ordinates at all load points in the graphs. One cannot, however, escape the conclusion that the theorem of three moments will not give reasonable results for the reactions of a continuous system with indeterminate yielding supports such as occurs on arches of this type.

If it is admitted that the deck, by its stiffness, relieves the arch ring of its theoretical concentrated loads, it follows that the deck, particularly the jack arches, should be adequately reinforced to perform this function without damage.

Although there is no accepted theory with which to compare the results of this test, we feel, from similar tests on other types of structures, that the results obtained by this method of analysis may be followed with confidence.

Future Expansion Observations—The clean-cut character of the expansion joints between deck spans affords an unusual opportunity to make field observations of expansion and contraction in the deck. Accordingly, near the base of both railings at each of twelve consecutive expansion joints there are installed a pair of Monel metal plugs with spherical ends approximately 1 in. apart as shown in Fig. 9. The clear distance between these plugs will be measured by means of inside micrometer calipers when temperature conditions are uniform, and the temperature and individual readings will be recorded on metal tablets at each joint for future reference. On the face of each plug is a fine-cut vertical line exactly ½ in. from the spherical end so that the distance between these lines will be exactly 1 in. greater than the space between the spherical ends. As the distance between lines can be readily measured by means of a scale, any engineer who is interested may make rough measurements at any time and compare with the original record.

During construction, the Department of Highways co-operated with the committee on concrete and reinforced-concrete arches, Am. Soc. C.E. (Prof. Clyde T. Morris, chairman), by making field observations on the tilting of piers incident to varying conditions of arch loadings. The readings were taken by the use of a delicately acting level-bar. The readings were turned over to the committee for such use and interpretation as it may see fit to make.

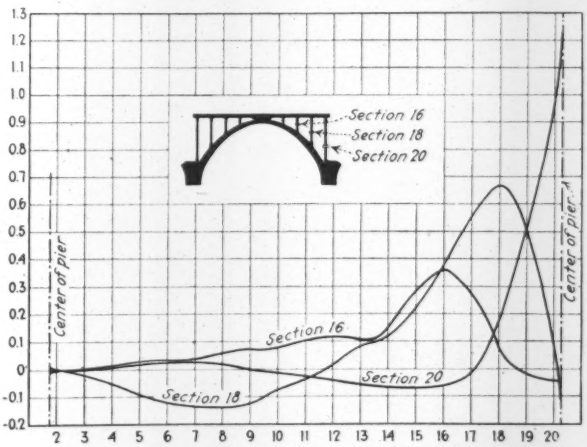


FIG. 8—INFLUENCE LINES FOR DIRECT STRESS IN SPANDREL COLUMNS

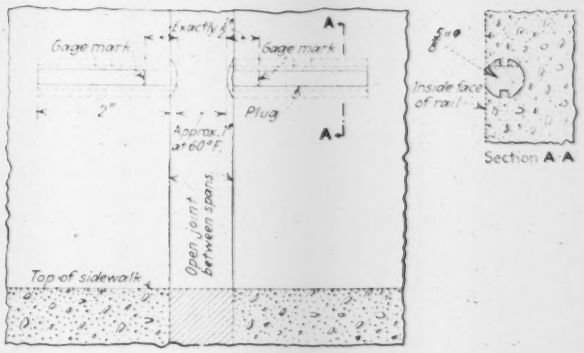


FIG. 9—METAL GAGES PLACED IN STRUCTURE FOR FUTURE EXPANSION MEASUREMENTS

Administration—The design of the viaduct was begun in 1923 under the direction of the writer as special designing engineer assigned to this project by the director of highways. Much of the work was done in the office of the county engineer by D. W. Leggett, resident engineer for the state, and A. G. Bixler, who later had direct charge of construction, assisted by T. W. Kinnear. L. A. Breen is division engineer for this district, and H. P. Chapman is engineer-inspector for the department in the eastern half of the state, in which the structure is located; he also assisted in the design.

Due to lack of funds, letting of the work was delayed after completion of the design, the award being made in November, 1926, to the Standish Engineering Corporation, Chicago, at its low bid of $378,125.30 for the viaduct and $61,863.73 for the approaches. In addition, there was an item of $68,000 for right-of-way. Alex Cross was superintendent of construction. During construction the writer has been associated with the project as chief engineer of bridges in the State Department of Highways.

The viaduct proper is a federal-aid project, being financed with federal and county funds in equal portions, while the state and county bear the expenses of the approach construction. The project has been administered by G. F. Schlesinger and H. J. Kirk as successive directors of the highway department, of which R. S. Beightler is chief engineer.

Wisconsin Road Construction Progress During 1928

At the close of the third quarter the Wisconsin State Highway Department reports the major portion of the 1928 program let and under way. The combined federal and state aid work comprises 186 miles of concrete, 139.3 of gravel, 133.9 of crushed stone, 13.3 of shale, 78.1 miles of grading and 22 bridges. With country bond issue funds an additional 116 miles of concrete was built. About 3,200 miles of highway has been signed and marked in 1928. On the state trunk highway 50 grade crossings will be eliminated by closing or diversion, and eleven new bridges over railroad tracks and seven subways under them will eliminate eighteen more grade crossings.

Committee on Cross-Connections Submits Final Report

N.E.W.W.A. to Ballot on New Compromise Resolution, Which Some Regard as Too Weak and Some as Too Strong

AFTER an extended debate from the floor in which several speakers contended that the resolution offered by the committee on cross-connection was too weak and made unsuccessful attempts at amendments to strengthen it, and after letters had been read from two members of the committee protesting that the resolution was too strong, the members of the New England Water Works Association present at a luncheon meeting held on Dec. 12 voted to send to letter ballot the resolution included in the final report of the committee.

The committee first reported to a luncheon meeting of the association in March of the present year (see lengthy abstract, with conclusions and proposed resolutions in full, published in *Engineering News-Record*, March 22, 1928, p. 489, with editorial comment on p. 464 of the same issue). Opposition to the resolutions then proposed led to the withdrawal of the resolutions and a vote to print the report in full in the June issue of the *Journal* of the association for consideration at a later meeting. At the Montreal convention (see report in *Engineering News-Record*, Sept. 17, 1928, p. 475) the committee stated that new factors had entered into the case and advised formal action at a later meeting.

The final report, submitted Dec. 12, contained some revisions and new matter and a single short resolution in place of several resolutions in the March report. The conclusions of the final report were largely the same as those of the report submitted in March but contained an entirely new paragraph relating to the stand-by automatic chlorinator for attachment to fire pumps at industrial plants, tentatively approved by the New York State Department of Health (see *Engineering News-Record*, July 12, 1928, p. 75).

This new paragraph together with two succeeding paragraphs changed in the final report as compared with the March report read as follows:

The committee is of the opinion that the recently developed chlorinator for auxiliary supplies offers another valuable means of defense against bacteriological contamination of public water supplies through cross-connections. However, the committee believes that more experience must be gained with this device before it can be unqualifiedly recommended. Properly operated and maintained, the device provides a method for making polluted auxiliary supplies bacteriologically safe, even though such supplies might continue to be non-potable.

Your committee does not approve the use of cross-connections between safe and unsafe supplies, and wherever auxiliary supplies are made safe by treatment there should be provided the additional safeguard of proper and properly installed and inspected double check-valves. Furthermore, these valves should be used between drinking water supplies and those that while unpotable—like pure sea water—do not require treatment to make them safe.

The committee strongly urges that states adopt suitable laws and regulations covering the control of cross-connections and that in each community an investigation of the existing cross-connections be made immediately and a program for the elimination or control thereof be inaugurated by the local authorities. The committee also urges that, where possible, the inspections be made through the co-operative efforts of state and municipal authorities on the one hand and owners and insurance companies on the other. Inspections of all installations of protective devices should be made at least quarterly by an official responsible for the quality of the public water supply and such devices should be overhauled yearly.

The resolution offered by the committee at the meeting on Dec. 12 and ordered sent out to members for letter ballot follows:

Whereas evidence shows that the existence of certain cross-connections between safe public water supplies and unsafe private water supplies, not equipped with modern protective devices, has resulted in many outbreaks of disease and many deaths, and

Whereas, such cross-connections are a hazardous part of any water-supply system.

1. This association recommends that no cross-connection be permitted with a supply that in the opinion of the state health authorities is bacterially unsafe.

2. This association recommends that any cross-connection permitted with a bacterially safe but non-potable supply shall be made through a properly installed and adequately supervised all-bronze, rubber-seated, double check-valve of a type approved by the state health authorities.

The advance printed copies of the final report contained, as signers, the names of all ten members, but it appears from statements after the report had been submitted that changes in the resolution made just before sending the report to print were not fully approved by two members of the committee. The ten members were: Robert Spurr Weston, chairman; John S. Caldwell, E. Sherman Chase, secretary; Stephen DeM. Gage, Charles D. Howard, Arthur C. King, H. O. Lacount, Warren J. Scott, Stephen H. Taylor, Arthur D. Weston.

Of these ten members Messrs. Weston and Chase represent consulting engineers, Mr. Caldwell the general fire insurance interests, Mr. Lacount the factory mutual companies, Messrs. Gage, Howard, Scott and Weston the engineering staffs of state boards of health, while Mr. Chase is an assistant superintendent of water-works.

The dissent from committee members came from Messrs. Howard and Gage. Mr. Howard's letter, except for the omission of certain intracommittee matters, follows:

As these resolutions now read they are unqualifiedly opposed to the use of any type of connection whatsoever as involving a source which is bacterially unsafe. It is true that there is still retained reference to the use of bronze checks, but in the present form these are to be tolerated only against supplies which, while "non-potable," are "*bacterially safe.*"

This, I think, comes dangerously close to being a quibble, because in actual practice there are virtually no sources so used in New England (if we except sea water and usually not even then) which, while "non-potable, are bacterially safe." Certainly we have none here in the State of New Hampshire.

In thus unequivocally condemning the retention of any form of connection, even as a temporary expedient and permitted at the discretion of the state boards of health, it cannot be denied that this is likely to be provocative of some embarrassment, because at this time very many double check connections are in use throughout New England, these having been installed in the first instance as seemingly the best cure possible for what the mill managements have insisted is an unavoidable evil, and, in view of the uniformly good test records which they are affording, there seems excellent ground for a belief that, despite the adoption of resolutions of this character, most of these connections will, in actuality, continue to exist—in other states as well as in the writer's own.

The . . . resolutions [referring to earlier counter-proposals] with slight modifications of the wording, were both, in my opinion, more sane and reasonable expressions than is the final form, which, I cannot help being impressed, is something put together with the dominating thought of getting it accepted by an organization the rank and file of

which may or may not be more competent to judge this matter than is its duly selected committee.

The substance of Mr. Gage's letter was:

I feel that my position with regard to absolute abolition of cross-connections is much the same as that of Mr. Howard. It will be impossible for us to completely eliminate them in Rhode Island, and I must give my tacit assent to such connections remaining in place in certain cases. I feel that Mr. Howard is entirely right in that the last set of resolutions go further than was the original intent of the members of the committee as I understood them.

Aged Pump Driven by Waterwheel at Alexandria, Va.

By James H. Le Van

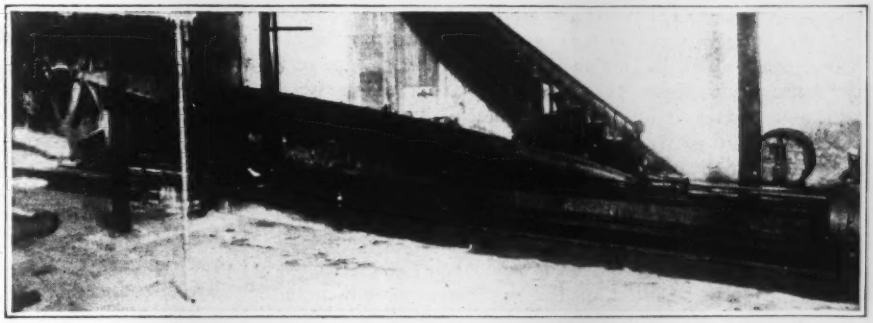
With Hazen & Whipple, Civil Engineers, New York City

WHAT is believed to be a record for long service by a piece of moving machinery is held by the pump illustrated herewith. It was built by the I. P. Morris Company, of Philadelphia, Pa., in 1851. For 77 years, since it was first put in operation, the pump has continuously supplied Alexandria, Va., 0.8 m.g. of water per day, and today is still a part of the regular pumping equipment.

It was originally driven by a wooden overshot wheel, replaced some 25 years ago by a steel overshot wheel made by the Fitz Water Wheel Company, Hanover, Pa. This wheel is on the same shaft as a cast-iron flywheel, connected with the pump by an iron-bound beam 39 ft. long. The pump cylinder has a 10-in. bore and is 10 ft. long. The piston has a 9-ft. stroke. The pump and flywheel work at 9 r.p.m. The pump delivers the water to the filtration plant against a head of 110 ft. The pulsations are smoothed out by an enormous air receiver, of cast iron, 3 ft. in diameter and 9 ft. high, on the discharge pipe. With the exception of bronze bearings for the connecting rod the pump is made *entirely* of cast iron.

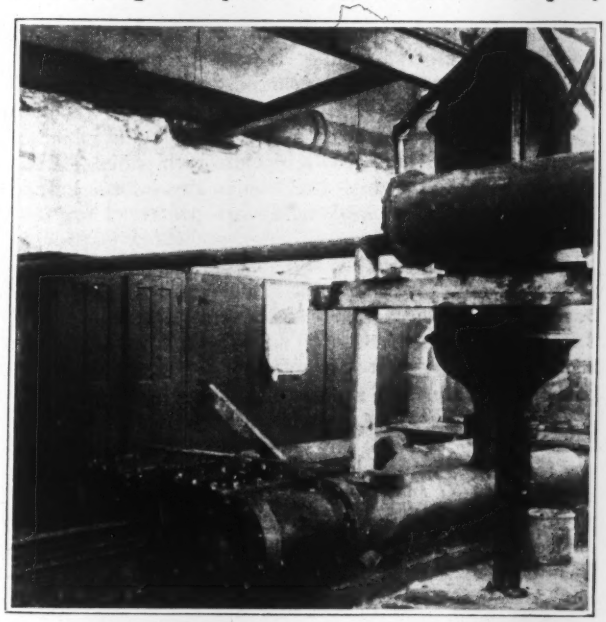
Compared with a water-turbine-driven centrifugal pump recently installed in the same station, the old pump occupies about eight times the floor space, runs at about one-two hundredths of the speed and has apparently the same over-all efficiency. The only serious trouble experienced in the 77 years of service occurred several years ago when a large crack developed in one end of the wooden connecting rod. This was repaired by bolting a flat iron plate on each side of the rod, as shown in one of the illustrations on this page. With occasional renewing of the check values and repacking the cylinder it has a fair prospect of outlasting its modern high-speed rival.

The pumping station and head and tail race structures are known to be more than 200 years old, having been a flour mill in Colonial days.



WATERWHEEL-DRIVEN PUMP INSTALLED IN 1851

Ironbound inclined wood beam and horizontal iron rod connect pump piston to cast-iron flywheel on axis of waterwheel (not shown in view).



WATER END OF OLD PUMP AT ALEXANDRIA

Piston works in middle cylinder, beyond which is supply pipe, while at right is discharge pipe, on which is large cast-iron relief chamber. Valve chambers on either side of piston head.

Grade-Crossing Elimination in New York

Grade-crossing elimination in New York State under the provisions of the $300,000,000 bond issue has now progressed to the point where definite results are evident. Data from the engineering division of the Department of Public Works show that since the law went into effect the Public Service Commission, which has jurisdiction over grade crossings outside of Greater New York, has ordered 234 eliminations at a cost of $27,200,000. The legislature has appropriated $60,000,000 for eliminations outside of Greater New York and has sold $10,000,000 worth of bonds. Further bonds will be sold as needed. To date $765,876.45 has actually been paid out of the state treasury toward the cost of grade-crossing eliminations.

In 1928 the law was amended so that the state pays 40 instead of 25 per cent of the cost, and the municipality 10 instead of 25 per cent as formerly, with the percentage to be paid by the railroad company remaining at 50 per cent. Under the 1928 law, the Public Service Commission has ordered 43 eliminations at a cost of $7,125,000. Thirty-six contracts are actually under way at a value of more than $2,000,000, and the commission each week is adding to the list of orders and approving low bids for construction work of jobs previously ordered.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

A Great Work on Hydraulic Laboratories

REVIEWED BY CLEMENS HERSCHEL
Consulting Engineer, Retired, New York City

HYDRAULIC LABORATORY PRACTICE: Comprising a Translation, Revised to 1929, of Die Wasserbaulaboritorien Europas, Published in 1926 by *Verein Deutscher Ingenieure*. Including also Descriptions of Other European and American Laboratories and Notes on the Theory of Experiments With Models—Edited by John R. Freeman. New York: The American Society of Mechanical Engineers. Cloth; 9x12 in.; pp. xxi + 866; 989 halftones and line cuts. $10. *On sale in January.*

One of the surprises of the recent annual convention of the American Society of Mechanical Engineers was an "advance copy" of "Hydraulic Laboratory Practice," more popularly known as "Freeman's Book on Hydraulic Laboratories," a translation and re-issue brought down to date of the German book on that subject reviewed in the June number of *Mechanical Engineering*, 1926. Less than 900 quarto pages in extent and weighing not much if any inside of 10 lb., it is a weighty contribution to our hydraulic knowledge of today. Pleasantry aside, here is a book that is undoubtedly destined to have a notable effect upon the advance in the United States of learning in applied hydraulics. Not the kind that speculates, argues and discusses, or, still less, theoretical hydraulics as such, but the art as it seeks, finds and thereupon knows. A book that no doubt is destined to be cited as the friend of the hydraulic engineer and to make straight the way of advancement of the profession in which he works and aims to benefit mankind.

Perhaps this is the appropriate place to speak once again, but none too often, of the great benefit Mr. Freeman has conferred upon hydraulic engineering, first, by needed substantial aid in making possible the publication of the German book, in 1926; then by endowing a series of traveling scholarships in the art; and now by editing and causing to be published the volume here under review; not to mention the agitation in behalf of additional and more efficacious hydraulic laboratory work in the United States that he has been carrying on, lo, this many a year. It has got to come. Some of us believe in it too strongly ever to abandon the fight for it.

Heartening is a review of what has already been accomplished on those lines the world over. When Weisbach (hallowed name in 1860, for hydraulic engineers in the United States) made his hydraulic experiments in the '40s and '50s of the last century, he used a reservoir to measure discharges, about 1¼ sq.ft. in area. Francis, in the '50s, used a wheelpit and an old canal lock, 506 and 1,277 sq.ft. in area, respectively, and thereby astounded the world of hydraulic engineers. In fact his reservoirs to measure discharge remained a record until very recently. But the German National Hydraulic Observatory of 1928, an endowed institution, endowed, moreover, so as to *operate continuously*, which has greatly surpassed, or unquestionably will surpass in its capabilities and actualities, even those described in the book under review, has a measuring reservoir of about 2,100 sq.ft. (87,500 cu.ft. of disposable volume), and that splendid institution looks forward to experimenting today and every day, in one way or another, with quantities of from 150 to 850 sec.-ft.

In a lifetime nearly spent, the greater part of it as a hydraulic engineer, the writer knows of no institution so calculated to advance the art of hydraulic engineering as this national hydraulic observatory. It repreesnts to him a dream come true; and was brought about, no doubt, largely by the success attending the work of the educational institutions described in the book under review.

But let us return to a consideration of the Freeman book itself. Historians are already tracing the history of hydraulic laboratories to Engels' river improvement laboratory of Dresden and of 1893, as the first of modern construction; and ascribing it in genealogical ascending order to Engels, Zeuner and our old friend Weisbach. On p. 23 of the book before us is perhaps the only succinct account in print of the work of that elusive American genius Hiram F. Mills, originally of Francis' office in Lowell, then of Lawrence, then of Lowell again. The Holyoke Testing Flume of 1882 to date gets its meed of praise; certainly a deserved one, for ever since the '80s it has been the scene of operations and diligently patronized by American wheel builders, in order that American hydraulic turbine construction might advance and flourish. On p. 761 is a history of hydraulic laboratories built to date and covered by the book.

Practically all notable laborers in the advancement of hydraulic engineering—Winkel, Moller, Krey, Thoma, Forschheimer, Timonoff and a lot more—are biographically introduced to the reader, and their work, past and present, is described to him. The classified list, or index, of experiments at the end of the book, and the bibliographies printed throughout it—these alone, in the language of the good book agent, "are worth the price of the whole book."

It is curious to observe that though rounded crests on weirs have attracted the attention of many, yet do they all persist in making perpendicular the *back* of the weir; which a sympathetic feeling, if nothing more, for the water passing over would assuredly make inclined or beveling downstream.

"Prevention of toe erosion" at dams, upon which a sizable literature has grown up on both sides of the Atlantic, gets its meed of attention in the volume before us. The milder forms of action are preferred to "dissipation of energy."

Not the least interesting part is a discussion, p. 579, by our old friend and visitor de Thierry, of Berlin, who, having been in the United States, and lectured for the Massachusetts Institute of Technology, knows how to talk the language of this country.

About 25 years ago, the writer, then as now, quite well known as a practitioner, even inventor, in hydraulic work, made application to a richly endowed national institution, one founded and endowed for the furtherance of the sciences, to have allotted to him a sum of money that he might make certain hydraulic experiments, whose resultant benefit to mankind he could foresee and did describe. The answer made and insisted upon was that "this institution" is not interested in applied, only in a theoretical, discussion of hydraulics. The reviewer recalls and presents this old rebuff with especial unction when he thankfully compares that response with the situation of today as it may be gleaned from the book under review.

Well-Known Work in New Edition

REVIEWED BY ARTHUR R. LORD

President, Lord & Holinger, Architectural Engineers, Chicago

CONCRETE, PLAIN AND REINFORCED: Vol. II. Theory and Design of Continuous Beams, Frames, Building Frames and Arches—By the Late Frederick W. Taylor, Sanford E. Thompson, S.B., and Edward Smulski, C.E. Fourth Edition. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6x9 in.; pp. 688; 263 line cuts. $7.50.

Material not included in the earlier editions of Taylor and Thompson's classic work on reinforced concrete is given in the present edition, in recognition of the increasing use of rigid frame analysis in the design of reinforced-concrete structures. It is obvious that all reinforced-concrete structures are in fact rigid frames and that a structural steel frame properly braced in the usual manner against wind is likewise a rigid frame, regardless of any lack of recognition of this fact by the designer. While this volume has been prepared as a portion of a treatise on concrete, the material and method of treatment are equally applicable in general to steel construction.

Chapter I, comprising more than 200 pp., is by far the most complete treatment in any language of continuous beams with uniform moment of inertia, which are *freely supported at intermediate supports* and either freely supported or fixed at the two end supports, that has ever come to my attention. The exposition is exceptionally clear, and numerous cases of one-, two-, three- and four-span beams, under uniform or concentrated loadings extending over part or all of the spans, are solved. The case of unequal spans for such beams is handled in very usable form. Such formulas may properly be applied to the design of concrete slabs, joists or beams resting upon a steel framework. They do not apply to rectangular slabs, joists and beams built monolithically with concrete columns and girders at their intermediate supports, which is far more common construction. Nor do they apply to T-beams where the moment of inertia at the center is often twice that at the support. But within the limited range in which they do apply this set of solutions is exceptionally complete and usable.

The treatment of the effect of varying moment of inertia starts with cases in which the I at the center of span is one-fiftieth of that at the support and stops when they are equal. In actual buildings it is far more common that the I at the center of span exceeds that at the support, since T-beams and T-joists are the usual flexural members employed in design. The authors seem to have had the *rectangular beam* and the one-way slab with or without brackets most in mind in this whole treatment. The method of computing moment of inertia of a reinforced-concrete member in flexure, as given, is satisfactory for preliminary design, but the final design should be made more accurately.

The analysis of bending and direct compression is exceptionally complete for rectangular sections, although here, as in other parts of the book, departures from standard notation result in unnecessary confusion and delay to the reader. Many diagrams are saved by giving only those for $n = 15$ and by supplying two simple conversion tables for other values of n. Circular sections are not discussed.

The treatment of rigid frames is also characterized by detailed solutions of many cases, such as have heretofore been available chiefly in European texts. These are limited largely to structures of one or two panels in width, leaving the more common multi-bay building to be worked out by the general slope-deflection equations which are given. This portion of the book is very usable in both concrete and steel design, but it is a matter of regret that the great possibilities for a condensed treatment, more applicable to rapid design, have not been realized.

Four chapters are devoted to the treatment of right arches, distinguished by simple effective analysis and by clear exposition of the basic structural action. Both approximate and "exact" methods are given. Shrinkage is handed a death bolw in a few words, but the reviewer suspects that it will come to life again and require more adequate treatment by the designer who uses this book.

It is difficult to sum up one's impressions of this work. It contains a wealth of special cases solved in detail — which means great saving of time and labor when such cases fit—but the cases selected are quite special and apply to the more unusual rather than to the more common framing members used in reinforced-concrete design. With so many good books on concrete already in our personal libraries, the extent to which one can use these solutions of special cases may easily be the determining factor in the purchase of this book. The clarity of many of the explanations of flexure and arch action make it an unusually good book for the novice to *study*—and the very multitude of special cases of extremely limited applicability make it a dangerous book for the novice to *use*. Both novices and experts will want to have the book available for reference, even if they do not own a copy.

Exhaustive Coverage of Parks

PARKS: A Manual of Municipal and County Parks—Compiled as a result of a nation-wide study conducted by the Playground and Recreation Association of America in co-operation with the American Institute of Park Executives at the request of the National Conference on Outdoor Recreation. The study was made possible through funds granted by the Laura Spelman Rockefeller Memorial. Edited by L. H. Weir, Director of the Study. New York: A. S. Barnes & Co. Cloth; 8x11 in.; pp. 1032; 374 illustrations. In two volumes; $15 until Dec. 31, then $20.

In plan, scope, execution and final production in book form this is far the most comprehensive and serviceable work on parks ever published. After a brief historical review, the "why" of parks is discussed at length. The general planning of park systems is then taken up and many examples are described. Going more into detail, there is a long chapter on elements of design and a still longer one on construction. The first volume closes with chapters on administrative control and on financing. The second volume takes up general executive organization, office organization and management, organization engineering, maintenance, horticultural, recreation and police divisions, lighting and sanitation. Zoological parks, aquariums and botanical gardens are next considered. There are chapters on educational publicity and on training park executives. Besides references at chapter ends there is a general Bibliography. Each volume is separately indexed.

An abundance of local ordinances, rules, organization charts, summaries of office and other routine practice, classified planting lists, layout plans, designs of buildings and accessories, together with many halftone views, contribute to the exhaustive character of the work, which, through the use of small type in parallel columns for a vast amount of documentary and other quoted matter, is far more extensive than the mere number of pages, many as there are, indicate.

Few if any branches of municipal service have ever been so thoroughly treated as has parks in these two handsome and useful volumes. The recognition given to

engineers and engineering work in park design and construction is notable. This and other facts and suggestions in the work point to a larger number of engineers, both present and prospective, engaged in park engineering than is generally known. It should be added that the treatise shows no lack of attention to the landscape and other specialists essential to the full development and utilization of parks and playgrounds.

Farm Land Drainage and Clearing

LAND DRAINAGE AND RECLAMATION—By Quincy Claude Ayres, C. E., Associate Professor, in Charge of Drainage and Irrigation Engineering, Agricultural Engineering Department, Iowa State College; and Daniels Scoates, A. E., Professor of Agricultural Engineering, Agricultural and Mechanical College of Texas. New York and London: McGraw-Hill Book Company, Inc. Cloth; 6x9 in.; pp. 406; 279 illustrations. $4.

Although the term "reclamation" is usually understood as including both the irrigation of dry lands and the drainage of wet lands, this book deals only with the drainage and clearing of land. It covers also surveying and legal matters relative to drainage work. The preface states that the book is intended primarily for agricultural students and may be useful as reference for practicing engineers, but curiously enough the "agricultural engineer" is not mentioned specifically, although in fact the book is for him quite as much as for the "drainage engineer," who is mentioned. It is also suggested that the book will be of value to the farmer, but its scope would seem rather beyond even the "progressive farmer." In fact, as the book seems to rather minimize engineering features, it might induce a farmer to undertake surveys or work requiring technical knowledge and skill for successful results.

Measuring distances, leveling, land and topographic surveying and the computing of areas are covered by nine chapters (74 pp.), followed by 13 pp. on earth dams and levees. Pumping is disposed of in one page. Then come short chapters on properties of soils and on rainfall and runoff, the latter giving methods of measuring flow in open channels. Three chapters deal with design, location, construction and maintenance of ditches, the maintenance including removal of vegetation. Various uses of explosives and different methods of clearing land from brush and stumps (73 pp.) are followed by 46 pp. on control of soil washing or erosion by terracing the surface and closing gullies. Seven chapters deal with subsurface drainage and tiling.

Drainage districts are described; their purpose, organization and assessment methods (21 pp.). This matter is supplemented by a chapter on legal affairs, since "it is essential that each farmer should understand his rights according to law regarding the water of the farm." The value of the book is largely in the line of farm drainage, and it is therefore more particularly useful for agricultural and drainage engineers and students in these branches of engineering.

An Expanding Field of Engineering

ICE ENGINEERING—By Howard T. Barnes, F.R.S., Professor and Former Director of Physics, McGill University, Montreal, Canada. Montreal: Renouf Publishing Co. Cloth; 6x9 in.; pp. 364; halftones and line cuts. $5.

On first thought ice engineering impresses one as an excessive extension of engineering functions. As a matter of fact there has been quite a notable practice in ice engineering developed in dam and breakwater building and in designing water intakes and penstocks. The author carries the practice further to the elimination of ice jams and the maintenance of navigation. He undertakes to provide ways of ice prevention as well as to develop remedial measures against the destructive forces that result while it is forming and afterward. The theme and its treatment are interesting, and any engineer having to deal with structures and construction in waters where ice forms thickly and in wide reaches can get much from this work that will help him.

Briefly, the first five chapters consider the physics of ice. In them the author develops his theory of ice growth and disintegration and discusses frazil ice and winter ice floods, density, hardness, specific heat and fusion, evaporation, elastic constants and bacteriology. Then come four chapters of direct bearing on engineering structures and construction: (1) Ice remedial work—use of steam, thermit, hot water, calcium chloride and other chemicals; (2) ice pressure and expansion; (3) conservation of heat in lakes and rivers for ice prevention; and (4) ice navigation and ice breaking. The concluding chapter is on glacier ice and icebergs.

Modern Street Building in Germany

REVIEWED BY HAROLD M. LEWIS

Executive Engineer, Regional Plan of New York and Its Environs

MODERNER STRASSENBAU: Steinstrassen, Teer- und Asphaltstrassen—Ein Handbuch des Praktischen Strassenbaues von Eduard Schneider, Strassenbau-Oberingenieur in Köln a. Rh. Berlin: Algemeiner Industrie. Cloth; 6x9 in.; pp. 479; 389 line cuts and halftones. 15 marks.

This book on modern street construction by Edward Schneider, highway engineer, of Cologne, is the second edition of a volume first published in 1925. It deals with the practical side of the problem rather than its technical phases and presents the observations of the author's more than 30 years' experience in highway work. The theory of highway design was dealt with more fully in the book by Prof. E. Neumann, "Neuzeitlicher Strassenbau," reviewed by the present writer in these columns March 15, 1928, p. 453.

Herr Schneider's book is more in the nature of a handbook and deals primarily with stone, asphalt and tar pavements. In addition to street construction it takes up many of the related problems which must be dealt with by technicians and officials connected with the building of highways. The original edition has been expanded from six to twelve chapters. The author points out the importance not only of building streets properly but of planning their location to serve the rapidly changing modern requirements—millions may be lost by mistakes.

In dealing with the various types of pavements, their composition and cross-sections are first discussed and then the methods of construction. At the close of each chapter are given sample specifications and complete cost figures. Of the eight chapters devoted to this type of material, one describes grading problems and waterbound macadam; one discusses stone pavements, which are still used much more extensively in Europe than in the United States; one outlines the uses of tar in surfacing streets; three chapters describe the various forms of asphalt, including sheet asphalt, asphalt macadam, the different bituminous pavements and the use of cold asphalt for surfacing; one is devoted to concrete pavements; and one takes up other miscellaneous types. Thus it is seen that the major emphasis is given to the uses of asphalt.

There then follows a chapter dealing with country roads (particularly methods of draining and disposing of water in low areas without sewer systems), special auto-

mobile roads and highways with special strips of paving as runways for the wheels of the vehicles using them. The final chapter deals with some of the important problems of operation and maintenance. This goes into considerable detail in regard to various safety features, such as guard rails, lighting and traffic signals and signs.

The book presents in compact form material that should be of use to both highway construction engineers and contractors. The specifications and cost figures are particularly complete and well arranged. While modern highway construction has been much more extensively developed in this country than in Europe, this book shows that the Germans have made great advances in the application of many different types of materials to highway construction. The results are clearly brought out in the many illustrations in the volume.

Italian Book on Dams

REVIEWED BY A. C. JANNI

Consulting Engineer, New York City

DIGHE: Serbatoi—Regime dei serbatoi—Dighe in muratura di graito—Dighe in muratura a volta—Dighe a volte multiple e di calcestruzzo armato—Dighe di terra di scogliera e di muratura a secco—Opere di derivazione e di scarico—Dighe mobili piane, cilindriche, a settore, a tetto, ad aghi e panconi—Appendice; Regolamento per i progretti, la costruzine e l'esercizio delle dighe di ritenuta. Milan: Ulrico Hoepli. Paper; 6x9 in.; 512 pp.; 442 illustrations; 5 tables.

The material of this book is divided into eight chapters, followed by a complete list of all the dams existing in Italy, up to 1927, and an Appendix containing the most recent Italian government laws regarding the construction of new dams, the government supervision during their construction and the maintenance of the old ones.

The author starts out with the exposition of hydrographic and hydrometric principles and of the various methods and formulas governing the computation of the volume of water collected in a given watershed, to be used either for irrigation, or power, or navigation, or potable water. In this connection he passes in review the most important works of this kind which have been carried out in the various countries of America and Europe. He is, naturally, more specific and detailed in the data relating to the hydrology of north Italian rivers, canals and watercourses, where irrigation, on a comparatively large scale, has been practiced for several centuries and where it is still regarded by hydraulic engineers as a model of its kind. All this material forms the first chapter of the book.

The following five chapters contain the classification and description of the various types of dams commonly used: earth, masonry, reinforced-concrete, movable dams and the other varieties which have developed from the above. The description of each type, which, in general, is clear and complete, is often accompanied by useful criticism.

The theoretical part—that is, the methods of analysis to be followed in designing any one of these dams—is somewhat lacking in details. It consists, mainly, of sketchy quotations from the various analyses of dams, and references to works upon the subject by well-known authors. This method adopted by the author is not altogether satisfactory. The book has little value as a textbook proper. It is not clear why, while he devotes so much space to explaining, for instance, the method of analysis for cylindrical dams, by H. Ritter (a method seldom used, because it is founded upon objectionable assumptions), he confines himself to giving only a summary information of the method by C. Guidi, which seems to be the best available work of the kind, as well as the most recent.

The last part of this book deals with works supplementary to the dam proper and with mechanical apparatus in connection therewith.

Taken as a whole, the book may be very useful to an engineer in his preliminary planning of a hydraulic project, for it is full of general information upon the various kinds of the most important hydraulic structures built all over the world, up to the present time. Undoubtedly, the author has made a diligent work of research and compilation, but there does not seem to be anything essentially new in the material he has put together—except for some information upon work which he received directly from its designer. The book is well written, and the great number of figures in the text contributes greatly to its clear exposition of the practical side of this branch of engineering.

Chemistry of Nitroglycerine Explosives

NITROGLYCERINE AND NITROGLYCERINE EXPLOSIVES—By Phokion Naoûm, Ph.D., Director of Scientific Laboratories, Alfred Nobel Dynamite Company, Hamburg, Germany. Authorized English Translation With Notes and Additions by E. M. Symmes, Hercules Powder Co., Wilmington, Del. (Vol. I of World Wide Chemical Series). Baltimore: Williams & Wilkins Co. Cloth; 7x10 in.; pp. 469; illustrated, chiefly by line cuts. $7.

Issued as a special volume as the author's part in a delayed plan of a group of experts to produce a large comprehensive handbook on the entire technique of explosives, this volume on nitroglycerine appeals mainly to the explosives chemist rather than to the practical powder user. The first part of the book deals with the chemistry and manufacture of nitroglycerine; physical, chemical and physiological properties are taken up in detail. Part II deals with the homologous and related nitric esters, their chemical properties and explosive effects.

Part III is the most practical section of the book, being a comprehensive study of the chemistry, manufacture, use and results of nitroglycerine explosives, including powdery dynamites, blasting gelatine, gelatine dynamite, low- and non-freezing nitroglycerine explosives, and nitroglycerine smokeless powders. Chapter XXIII of this section, on nitroglycerine explosives permissible in gaseous and dusty mines, is practically the only chapter in the entire book that is of direct interest to the actual user of explosives. The composition, handling and use of permissible explosives are very thoroughly-treated.

The book closes with a supplement on the qualitative and quantitative chemical analysis of explosives containing nitroglycerine.

Revised and Enlarged

ELEMENTS OF HYDROLOGY—By Adolph F. Meyer, C.E., M.Am.Soc.C.E., M.Am.Soc.M.E., Consulting Hydraulic Engineer; formerly Associate Professor of Hydraulic Engineering, University of Minnesota. Second Edition Revised. Cloth; 6x9 in.; pp. 522; 287 illustrations, mostly line cuts, including folding plates, also folding maps in colors. $5.

The eleven years which have elapsed since the first edition of this book was published have added greatly to the amount of data available on hydrologic subjects. Forty additional pages of new material are incorporated in the present edition, which has been brought up to date throughout. Precipitation studies by the Miami Conservancy District and by F. A. Marston are now included, together with further studies on the subject of short-duration rainfall intensities by the author, based on rec-

ords of the U. S. Weather Bureau at St. Paul and Minneapolis. New formulas for evaporation developed by Robert E. Horton and Ralph L. Parshall have been added to those previously discussed and compared. The chapter on runoff has been augmented by a summary of Ivan E. Houk's work at Dayton, C. C. Vermeule's studies of Eastern streams, and a table of observed floods from drainage basins varying from 1 to more than 1,000,000 square miles in area. Two new methods of making discharge measurements are described: the salt-velocity and pressure-wave methods. The neglect of the sharp-crested weir, however, mentioned by H. K. Barrows in his review of the first edition (*Engineering News-Record*, Sept. 20, 1917, p. 561) still continues.

The present prominence of flood control in engineering thought will reveal to many engineers a weakness in fundamental knowledge of hydrology. To these, particularly, this book should prove extremely useful.

Legal Aspects of Trade Associations

TRADE ASSOCIATIONS: The Legal Aspects—By Benjamin S. Kirsh, formerly Special Assistant to the U. S. Attorney in New York in the prosecution of Sherman Anti-Trust Cases. New York: Central Book Co. Cloth; 6x9 in.; pp. 271. $5.

Although the legal problems arising from the federation of independent business units is the primary concern of this book, enough of the basic economics and business settings in which all legal problems are enveloped is given to make the book readable and more easily practicable to use. In large part the text consists of previously published magazine articles which have been brought up to date by the author's own remarks. The book covers statistics, uniform cost accounting methods, credit bureau functions, foreign trade functions, collective purchasing and the restriction of distribution.

A Study of Commodity Prices

THE BEHAVIOR OF PRICES—By Frederick C. Mills, of the Staff of the National Bureau of Economic Research, With a Foreword by Edwin F. Gay and Wesley C. Mitchell, Directors of Research. New York: National Bureau of Economic Research, Inc. Cloth; 6x9 in.; pp. 598. $3.

Current prices of commodities are the integration of many complicated and diverse economic factors. At the same time they are of intensely practical significance to every business man in whose work the purchase and sale of commodities is an important factor. So the author of this book offers a detailed study of the behavior of prices, covering more than 200 specific commodities and taking into account the many influences that have come into action during the period from 1890 to 1927. Such a study in cause and effect applied to so basic and universal a factor in business operations as commodity prices should be of considerable practical value to the thoughtful business man as well as to students of economic trends.

Experiences of a Sales Engineer

THE SALES ENGINEER: Some Commercial Aspects of Metallurgical and Chemical Engineering—By Gilbert Rigg. London: Mining Publications, Ltd. Cloth; 5x7 in.; pp. 112. 10s.

Mr. Rigg's little book is so easy to read that one hardly suspects he is being subjected to a sermon on the philosophy of those men who sell engineering equipment and materials but are more engineers than salesmen. The author, "a sales engineer and not a salesman," tells his experiences in representing a large zinc company where he was called upon to answer questions of metallurgical and chemical engineering in such diverse fields as those of pigments and paints, rubber manufactu and steel sheet galvanizing. The author singles out t American Society for Testing Materials as one of t most virile influences and important aids in the field o sales engineering. The book is all that it is claime to be—namely, one man's idea of what the sales engine does and should do.

Publications Received

PREPARATION OF SLAG FOR MARKET is the subject of an industrial pamphlet issued by the National Slag Association, 9 Leader Building, Cleveland, Ohio.

MONTREAL HARBOR FACILITIES, shipping, piers, freight sheds and warehouses, coal- and grain-handling plants and railway terminals, and the great traffic development, are summarized in a 54-p. pamphlet issued by the Harbor Commissioners.

SIMPLIFIED PRACTICE RECOMMENDATIONS for Metal Lath, Roofing Ternes and Slate, Steel Lockers, Classification of Iron and Steel Scrap, and Commercial Forms have been issued by the U. S. Department of Commerce (Bureau of Standards), Washington, D. C.

ENGINEERING WORKS of the Sanitary District of Chicago, including the North Side activated-sludge plant put in use Oct. 3 and the West Side plant still under construction, are described in a handsome 104-p. illustrated pamphlet now being distributed free of charge (Sanitary District of Chicago, 910 South Michigan Ave., Chicago).

AN ANALYSIS OF THE MONTREAL TYPHOID EPIDEMIC of 1927 fills some 30 pp. of the latest annual report of Dr. S. Boucher, director of the Department of Health of Montreal. The 5,002 cases from Feb. 1 to Aug. 31 are classified in various ways. There were 533 deaths for the same period. Aside from facts and opinions confirming earlier reports that the outbreak was milk-borne Dr. Boucher leaves to a forthcoming report by the Provincial Board of Health a pronouncement on how and why the milk in question became infected.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

EL ARCO FUNICULAR: Ensayos Sobre un Nuevo Sistema de Puente—Original de D. Fernando Gallego Herrera, Ingeniero de Caminos. Madrid: Address the author, Escuela de Caminos. Paper; 6x8 in.; pp. 53; line cuts and halftones.

DIE BIEGUNG KREISSMETRISCHER PLATTEN von Veranderlicher Dicke—Von Dr.-Ing. Otto Pichler. Berlin: Julius Springer. Paper; 6x9 in.; pp. 60; diagrams. 4.5 marks.

CONSTRUCTION OF ALIGNMENT CHARTS—By George W. Sweet, S.B., Associate Professor of Machine Design, Massachusetts Institute of Technology. New York: John Wiley & Sons. Cloth; 6x8 in.; pp. 92; line cuts.

For "those who wish to gain a workable knowledge of the subject" without need for higher mathematics. After a chapter on conversions scales the book takes up equations of three and of more than three variables, and miscellaneous forms.

ENGINEERING DRAWING—By Harvey H. Jordan, B.S., Professor, and Randolph P. Haelscher, M.S., Associate Professor, of General Engineering Drawing, University of Illinois. Second Edition. Cloth; 6x9 in.; pp. 404; 247 line cuts. $3 net.

In this edition the chapter on orthographic projection has been rewritten for purposes of simplification and the old figures have been replaced by new. The chapters on lettering, use of instruments, and chart and diagram drawing have been expanded and other material has been added.

HANDBOOK OF DOMESTIC OIL HEATING—Edited by Harry F. Tapp, Technologist, American Oil Burner Association. New York: American Oil Burner Association. Flexible; 5x7 in.; pp. 383, thin paper; many line cuts. $3.

Designed "to supply those who are engaged or interested in the oil-heating industry authoritative information concerning the problems of combustion and heating that is necessary in the practical application of oil-heating equipment. The technical material is presented in as plain and concise a manner as is possible."

PLANNING PROBLEMS OF TOWN, CITY AND REGION: Papers and discussions at the Twentieth National Conference on City Planning—Held at Dallas and Fort Worth, Tex., May 7 to 10, 1928. Philadelphia: Published for the Conference by Wm. F. Fell & Co. Cloth; 6x9 in.; pp. 246.

Among the papers are: Mass and Density in Relation to Open Spaces and Traffic Facilities, by E. P. Goodrich, consulting engineer, New York City; What Is Comprehensive Zoning? Harland Bartholomew, city planning engineer, St. Louis, Mo.; The Planning of Undeveloped Areas, by George H. Herrald, planning engineer, St. Paul, Minn.; Airports and Airways and Their Relation to City and Regional Planning, by John Nolen, city planner, Cambridge, Mass.

News of the Week

Passaic Valley Flood-Control Plan Presented

Results of a flood-control investigation affecting the valley of the Passaic River in northeastern New Jersey are embodied in a report by Cornelius C. Vermeule, which has been presented to Governor Moore of New Jersey and will be laid before the legislature at the beginning of the next session in January. The plan, as recommended, proposes to reclaim 46,500 acres of marsh lands and to protect from high water industrial, business and residential properties to the value of approximately $120,000,000. This would be done by means of: (1) Dredging the present channel to greater depth; (2) installing flood gates in the present dam at Little Falls, N. J.; (3) the creation of an 8,500-acre lake, regulating the discharge of the Rockaway and Whippany rivers, tributaries of the Passaic; (4) digging a new channel from Pine Brook to Little Falls, N. J., approximately 4 miles long, replacing the present tortuous channel 14 miles long. The latter, however, would be retained for low-water use. The cost of the project is placed at approximately $12,000,000, and it is estimated that over $70,000,000 increase in land values would result.

Lincoln Highway Bascule Drops Into River

East Half of Two-Leaf Drawspan Over Hackensack River Between Jersey City and Newark, N. J., Fails While Being Lowered—Cause of Failure as Yet Undetermined

A REMARKABLE bascule bridge failure occurred on Saturday night, Dec. 15, about 10 o'clock, at the crossing of the Lincoln Highway over the Hackensack River between Newark and Jersey City, N. J. The east leaf of the double-leaf bascule fell into the river channel as it was being lowered from open position. The west leaf, which had not yet started down, was undamaged. The bridge, which carries heavy vehicular traffic and also the main street-car connection between Jersey City and Newark, was built less than two years ago, being placed in operation in November, 1927. It replaced a swing span in the same location which was wrecked by a steamer in 1922.

As soon as the wreckage of the east leaf is cleared away a timber pile trestle will be constructed to connect with the west leaf at the center of the river channel, thus providing a temporary crossing.

The failure is being investigated by a special committee appointed by W. G. Sloan, state highway engineer. The members of this committee are O. E. Hovey, assistant chief engineer of the American Bridge Company; Prof. George E. Beggs, of Princeton University; and D. B. Steinman, consulting engineer.

The bascule consists of two leaves 98 ft. long from trunnion to outer end and is about 48 ft. wide between trusses. It was designed by the Strauss Bascule Bridge Company, of Chicago, and is of its movable-counterweight type. It was fabricated by the American Bridge Company and erected, under supervision of the New Jersey State Highway Department, which now maintains it, by the Stillman-Delehanty-Ferris Company, contractors, of Jersey City.

The counterweight system is in the form of a balanced and articulated parallelogram over the tail section of the leaf. The rear member of this parallelogram consists of the concrete counterweight and a pair of heavy posts (each consisting of two built-up channels made of two angles and three plates and joined by angle lacing, one at each truss carrying its load down to pins in the ends of the tail sections of the trusses. The front member is a pair of fixed posts, one erected over the trunnion support of each truss and just back of the trunnion bearing; from a pin in the top of this fixed post a link extends to the top of the counterweight block, this link being parallel to the line connecting the trunnion pin with the tail pin. The fixed post and the upper link, which under ideal conditions carry no load stresses but serve only as a wind frame, were light members, the post being made of two 12-in. channels spread about 3 ft. at the base and connected by single angle diagonals.

The counterweight consisted of a block of concrete 20 ft. high, 11½ ft. wide and 48 ft. 10 in. long, weighing approximately 750 tons. In its down position (when the leaf was open) the counterweight cleared the roadway about 7 ft. As the leaf was lowered and the parallelogram assumed a more nearly rectangular shape, the counterweight block rose until in its highest position the bottom of the concrete block was 29 ft. above the roadway. It was in some intermediate position between low and high, and was rising, when the failure occurred, the bridge operator estimating that the leaf was between one-quarter and one-half down when he saw the north end of the counterweight move forward from its usual position followed by the crash of the structure.

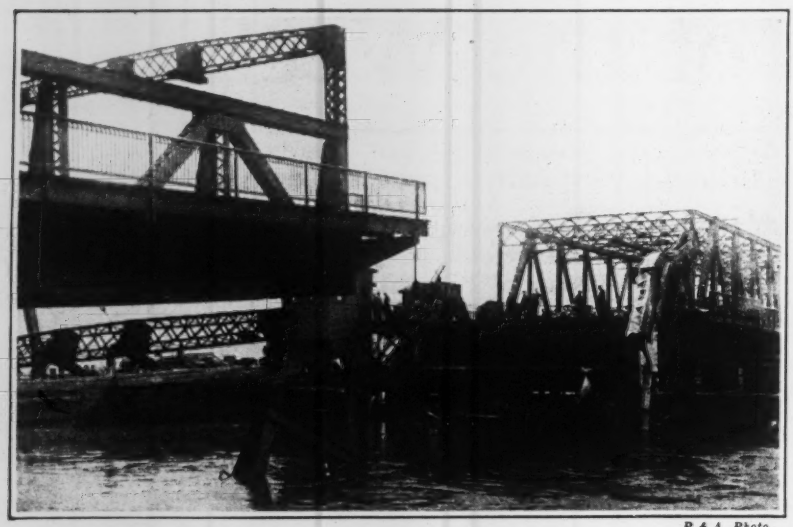
Boulder Dam Bill Passed by Congress

BY A vote of 64 to 11 the Senate on Dec. 14 passed, as amended, the bill authorizing the federal government to build a high dam in the Colorado River at the Black Canyon site. The House, on Dec. 18, approved the amended bill in its revised form by a vote of 166 to 122. It now goes to President Coolidge. The prevailing sentiment in Washington is that the measure is sufficiently in accord with the views of the President to receive his approval.

The bill, as passed, authorizes the Secretary of the Treasury to advance to the "Colorado River dam fund" amounts that are not to exceed $165,000,000. Of that amount, $25,000,000 is on the score of flood control. No work may be begun within a six-months period unless all of the states in the basin ratify the Colorado River compact; but after six months six of the states, which must include California, may ratify the compact.

The bill authorizes Arizona, California and Nevada to enter into an agreement providing that the 7,500,000 acre-ft. apportioned annually to the lower basin may be apportioned so that Arizona will receive 2,800,000 acre-ft. for exclusive beneficial consumptive use (diversions less returns to the river) in perpetuity. Nevada is to have 300,000 acre-ft. California's share is not to exceed 4,400,000 acre-ft. In the event of a surplus over the 7,500,000 acre-ft., California is entitled to one-half of any excess. The other half of such a surplus goes to Arizona. The amended bill gives Arizona "exclusive beneficial consumptive use" of the Gila River and its tributaries within the boundaries of that state.

The approved bill also directs that the Federal Power Commission may not grant permits or licenses affecting the Colorado River or its tributaries, except the Gila, until after the Colorado River compact will have become effective. The Secretary of the Interior, in his discretion, "may enter into contracts of lease of a unit or units of any government-built plant, with right to generate electrical energy or alternatively to enter into contracts of lease for the use of water for the generation of electrical energy." Full authority also is granted the government "to construct, operate and maintain a dam and incidental works."



P & A Photo

FIG. 1—WRECKED EAST LEAF OF THE HACKENSACK RIVER BASCULE ON THE LINCOLN HIGHWAY IN NEW JERSEY

In the left foreground the undamaged west leaf is shown in closed position. At the left (north side of wrecked leaf) the tailpiece and operating rack protrude from the water. Note the broken south top chord covered with concrete dust and bent toward the north. Note also the floor beam and torn gusset in the water.

A view of the wreckage (Fig. 1) shows both the north and south trunnion pedestals in place. The north trunnion bearing, pin and curved rack all fell into the river, only the back end of the rack being visible above the water. The operating pinion is still in place on the pier and undamaged. The complete counterweight structure over this pedestal is also under water, the front channel of the fixed post breaking off at the top of the pedestal and the rear channel leaving a projection of about 18 in. above the top. The break of the front channel showed bright metal and indicated a clean tension break. The break of the rear channel, on the other hand, showed three different conditions of metal. The north flange and about an inch of adjacent web were covered with old rust, indicating a crack of some age. Next to this rust there was a section of web about 8 in. long upon which the break showed bright and coarse texture, while the remainder of the web and the south flange exhibited a somewhat duller color but a more silky texture. The break occurred through the rivet holes holding the lacing and almost straight across. The rivet hole on the north side was lined with old rust, while that on the south side was of the dull silky finish. In front of the trunnion pedestal the live-load support, a low built-steel post on the pier, was distorted by a blow which appeared to have glanced off of the cap plate into the river (Fig. 2).

The south trunnion pin and bearing did not fall into the river, but the whole assembly was pulled forward off of the trunnion pedestal (Fig. 2), one of the bearings dropping off and landing on the bridge deck. Examination of the bronze bearing surface showed some evidence of wear. A portion of the top chord and the first web vertical are still hanging to the south wreckage. The top chord of two built-up webs laced top and bottom and with batten plates on top at the panel points was broken off squarely about 8 ft. from the end. The first vertical was buckled nearly 180 deg. upon itself. The top chord was covered with concrete dust and was badly crushed directly over the buckled web member, as shown in Fig. 2. The batten plate at this point was smashed by a blow that slid off of it toward the inside or north. A large group of rivets which connected the top chord gussets to the pin plates were clearly sheared and the north gusset of this member was cracked for nearly its full length. The fixed post of the parallelogram was bent sharply forward from its connection to the south trunnion pedestal, the angle lacing being buckled upon itself. The front channel of this member was badly buckled and was broken off about 4 ft. from the pedestal. The back channel was draped over the trunnion pin and extended nearly to the water, where it also was broken off. All of the wreckage on the south of the bridge was covered with dust from the counterweight and in position was inclined toward the north. The only wreckage protruding above the water on the south side is the end of a floor beam, evidently the one at the buckled first web vertical. The floor beams were fastened by kneebrace gussets extending practically the full height of the web verticals and all of the rivet holes through which this plate kneebrace of the visible floor beam was connected to the angles on the truss were torn free, apparently by a downward and northward pull. Neither the counterweight nor its two posts are visible.

Levels taken on the piers after the accident showed them to have been unaffected by previous dredging in the channel. According to engineers of the highway department, it is extremely unlikely that any of the pins bound because of lack of lubricant, since maintenance of the structure had been unusually thorough. The main trunnion and the tail pin were lubricated through pressure fittings, while the link pins at the top were of the automatic graphite type. Examination of the pins on the undamaged west leaf showed them to be well lubricated.

With mechanical defects tentatively eliminated, present indications point

World Wide Photo

FIG. 2—WRECKAGE OF HACKENSACK BASCULE BRIDGE LOOKING SOUTH

Trunnion pedestals in place. Note smashed condition of north live-load support. Counterweight post base can be seen upside down hanging from pin on tailpiece in foreground.

strongly to a structural failure of some sort. Although lacking the essential facts concerning the conditions of the counterweight posts, several deductions can be made from what is known. The inclination of the south wreckage toward the north, the battered south top chord showing unmistakable evidence that a terrific blow struck it and glanced off toward the north, and the torn condition of the floorbeam visible above the water indicate that the north side of the bridge failed first. These deductions are checked by the statement of the bridge operator, and by the fact that divers have found the north end of the counterweight to be about 18 ft. from the pier, while the south end is very close to the pier. As one looks to the north pier for some evidence of weakness, the cracked back channel of the fixed post commands immediate attention. Failure of this member during operation of the bridge would permit the counterweight to fall forward where it would be ineffective in checking the downward movement of the leaf. The smashed condition of the live-load support is evidence that the leaf fell upon it with great force. This also would tend to throw the counterweight and the tailpiece and operating rack some distance into the river. As stated, divers have located this end of the counterweight about 18 ft. from the pier.

Pending the report of the special commission and the raising and examination of the counterweight posts, the facts suggest that failure of the north fixed post occurred at an early stage, allowing this end of the counterweight to swing forward and thereby cause the north truss to fall.

The special commission appointed to examine the wreckage was at the site eight or nine hours after the collapse, viewing what could be seen, taking strain-gage measurements on the undamaged leaf and making preparations to examine the submerged wreckage as soon as it could be cut into moderate-sized pieces which could be lifted by the salvaging derrick. The report of this commission is not yet available.

Many Phases of Traffic Control Discussed at New York

Problems of street and highway traffic were discussed at the tenth annual meeting of the National Highway Traffic Association held in New York, Dec. 10-12, inclusive. Attendance at the meeting was small, generally about 30 people at each session, but this number included many engineers and administrators directly connected with traffic problems.

A large part of the time of the sessions was given over to the reports of committees of the association. These reports included one on the economic status of toll roads in the form of a written report by the chairman, Piero Puricelli, of Italy; reports on traffic control on long bridges and in tunnels, on illuminating highways, on traffic control on car tracks adjacent to safety zones, on terminology of traffic control, on traffic control on through and intercepting streets, on efficiency of marked lanes for wide roadways, on pedestrian control, on parking regulations and on elevated roadways. The principal addresses were one on economic utilization of highways by George H. Pride, president of the Pride Transportation Company; on the necessity of research in the solution of traffic-control problems by H. M. Gould, consulting transportation engineer, Detroit; on the future traffic problems of New York City by Philip D. Hoyt, chairman of the traffic board of the police department; on foresight and hindsight about dangerous curves and bridges by Arthur H. Blanchard, president of the association, and upon efficient street use by vehicles and pedestrians by Miller McClintock, director, Erskine Bureau of Street Traffic Research at Harvard University.

Many of the committee reports were elaborations of the recommendations of the National Conference on Street and Highway Safety. In general, the committee's findings agreed with the recommendations of the national conference.

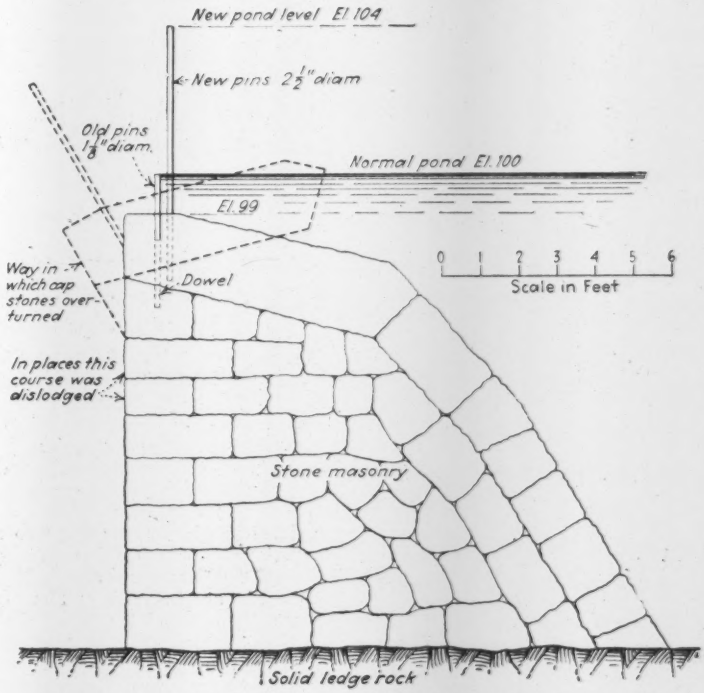
Failure of Small Dam Caused by Rise in Flashboard Height

A small dam across the Kennebec River at Madison, Me., suffered a partial failure Dec. 13. No lives were lost, but plants of the Madison Woolen Company, the American Woolen Company and the Great Northern Paper Company, which were dependent upon the dam for power, were forced to shut down.

Clifton S. Humphreys, of Madison, is authority for the following information about the failure. The dam was designed and built in 1895 and 1896 by Mr. Humphreys and Joseph P. Frizzell, hydraulic engineer, of Boston, Mass. It is a masonry structure with cut-stone face and cut-stone caps 8 ft. long, 2 ft. thick and from 18 to 30 in. wide. These caps were doweled to the next course below with 1¼-in. iron dowels, the joints between capstones being poured with melted sulphur. These joints show no signs of deterioration.

The normal pond level for which the dam was designed was El. 100, including flashboards 1 ft. high supported by 1¼-in. iron pins on a masonry crest at El. 99. After the dam had been in operation several years a study was made to determine the feasibility of raising the pond level. Mr. Humphreys recommended that it would be safe to increase the height of the flashboards to 3 ft., provided the supporting pins were not increased in diameter. This suggestion was followed and the dam has been successfully operated in this way for a number of years.

A few months ago it was decided to increase the pond level by increasing the flashboards' height to 5 ft., and the supporting pins to 2½ in. This was done, with the result that, with the water level approximately at the top of the new flashboards, about 200 ft. of the crest carried away as shown in the accompanying sketch. Apparently the supporting pins jack-knifed the capstones and the stretcher course next below, which was doweled to the capstones. The resulting rush of water dislodged a portion of the next lower course, but the remaining courses and the foundation were not damaged. It is expected that repairs will be made in the near future. Mr. Humphreys was not consulted before the final raise in flashboard height.



PARTIAL DAM FAILURE CAUSED BY RAISING FLASHBOARDS

Oscar F. Lackey to Head Road Commission of Maryland

Oscar F. Lackey, for many years prominently identified with the engineering profession, is to be appointed chairman of the Maryland State Roads Commission and will take up his duties not later than Jan. 1. John N. Mackall, who for some years has been serving as chairman of the commission and also chief engineer of that body, is to be relieved of the former office and will continue to fill the position of chief engineer. The change has been announced by Gov. Albert C. Ritchie and followed a recommendation made by a special committee investigating the workings of the State Roads Commission offices. Mr. Lackey will receive a salary of $4,500, and Mr. Mackall $8,000 as chief engineer.

Mr. Lackey has had long experience in engineering work. Starting in 1900, he spent five years in Cuba doing municipal engineering work for the U. S. War Department. He was president and chief engineer of the Harbor Board of Baltimore from 1906 to 1915. He then became assistant to the president of the Poole Engineering Company and later vice-president and manager of one of the munitions plants operated by the company. In 1918 Mr. Lackey became supervising engineer in the War Department in connection with the construction of port terminals in Boston, Philadelphia, Brooklyn, Norfolk, Charleston and New Orleans. He returned to Cuba in 1921 as consulting engineer in charge of designing a large sugar terminal. The following year he became vice-president and general manager of the Colorado Springs (Colo.) Light, Heat & Power Company, and then designed bulkhead and wharf projects in Philadelphia. Mr. Lackey returned to Baltimore in 1924 and took charge of the municipal Department of Transportation. He left this post in 1927 and since that time has engaged in consulting engineering work in Baltimore.

Two Papers on Industrial Waste at New Jersey Meeting

Trade wastes were the subjects of papers read before the 54th annual meeting of the New Jersey Public Health and Sanitary Association at Princeton on Dec. 6, by H. P. Croft, chief engineer, New Jersey State Department of Health, and by Dr. Wilhelm Rudolfs, chief of the sewage substation, New Jersey Agricultural Experiment Station, New Brunswick, N. J. Mr. Croft considered the subject from a public health standpoint and Dr. Rudolfs from the economic viewpoint. Mr. Croft reviewed the New Jersey statutes dealing with trade wastes. The discharge of these wastes into streams so as to affect public water supplies is under the supervision of the State Department of Health. An act of 1921 makes it necessary for new factories to obtain a license from the department before they begin to discharge trade wastes above the intake of any public water supply. Mr. Croft stated that a bill designed to give the State Department of Health and the State Sewage Experiment Station of New Brunswick power to investigate and report on trade wastes failed to pass the legislature of 1928.

Dr. Rudolfs said that there are about 700 separate industries, exclusive of dairies and laundries, that discharge wastes into the waters of the state. In many cases industrial wastes could be treated at less cost by themselves than if the wastes were discharged into city sewers. If, however, the industries were compelled by law to treat their wastes at their own cost, they would be handicapped in competition with industries in other states where such was not the requirement. Dr. Rudolfs expressed himself in favor of an investigation of the trade waste problem of New Jersey with the major part of the cost borne by the industries. On motion of Chester G. Wigley, consulting engineer, Atlantic City Sewerage Company, the association introduced a resolution for adoption by the association urging the legislature to authorize the study proposed by the bill which failed of passage in 1928.

Akron Opens New Sewage Plant

Official opening of the new 33-m.g.d. sewage-treatment plant at Akron, Ohio, took place Dec. 12, when about 250 persons, including city officials, A. L. Shaw, of Metcalf & Eddy, consulting engineers for the plant, and representatives of the contractors and the city engineering staff made a tour of inspection. The plant consists of bar screens; two detritus tanks 55 ft. in diameter and 15 ft. deep; two fine screens 6 ft. long and 6 ft. in diameter; 24 Imhoff tanks 27½x75 ft., 28 ft. deep; fourteen acres of trickling filters 10 ft. deep; twelve humus tanks 65x50 ft., 12 ft. deep, and four acres of sludge-drying beds. It was described in *Engineering News-Record*, March 13, 1924, p. 461, and Nov. 17, 1927, p. 784. The cost was approximately $3,614,000. The plant was built for the Department of Public Service of Akron, Metcalf & Eddy, consulting engineers; the Walsh Construction Company, Davenport, Iowa, general contractors.

States to Take Over Columbia River Bridge

Operation of the interstate bridge across the Columbia River between Clark County, Wash., and Multnomah County, Ore., by the states of Oregon and Washington will begin Jan. 1, 1929. It is planned to have the bridge toll free, except to certified public carriers. The revenue and cost of operation will be divided equally between the two states. Annual cost of operation is approximately $45,000 and revenue in 1927 was estimated at $60,910. The bridge, which was opened to traffic Feb. 17, 1917, cost $1,683,000. Washington will pay Clark County $250,000 for its share of the structure and Oregon will pay Multnomah County $125,000.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Build New Mississippi Levees Soon—Prospects for Illinois Channel—New Tunnel Proposed

CONSTRUCTION of the Bird's Point-New Madrid floodway, one of the major operations provided for in the flood-control act, is expected to be started soon, according to the Corps of Engineers. It is stated that the right-of-way necessary for the back levee of this river-bank floodway will be obtained through condemnation proceedings, since the prices asked are regarded as excessive. Flowage rights within the floodway will be purchased if they can be obtained at what the engineers believe to be reasonable amounts, it is declared. Although but one crevasse occurred in this section during the 1927 floods, the extreme water stage was such as to cause apprehension for the safety of Cairo and the entire St. Francis Valley. As the water is to be passed into this floodway through breaches in the old levee, the exact amount of the diversion cannot be predicted, but it is estimated at 450,000 sec.-ft.

Action also is expected soon on the construction of a new levee 30 miles long in the Bayou des Glaises section in Louisiana. Most of the land prices for the work in this section have been received by the War Department. The construction of this levee will permit the abandonment of the levees in the Big Bend district.

Illinois Waterway

Due largely to a disinclination to revive the Chicago diversion controversy, observers at the Capitol do not anticipate that the Illinois delegation will actively support any plan to involve the federal government further in the construction of the Lakes-to-the-Gulf waterway. Were it not for the diversion issue, however, it is known that the Illinois supporters of the waterway project would greatly desire to have the government increase its aid. The reason for this is due to the expensive litigation and increased construction costs with which the state has had to deal in its portion of the project from Lockport to Utica. The $20,000,000 bond issue, authorized in 1908 to complete this work, has been practically exhausted, it is stated.

It is estimated that $3,500,000 is needed to finish the section allotted to the state. There are other reasons, besides the apprehension over the diversion situation, why it is not believed that the Illinois members of Congress care to obtain this additional amount needed from the federal government. One of these reasons concerns the matter of power development at the five locks in the state's section of the project. There is a 165-ft. fall in that section of the waterway. Backers of

the undertaking have relied upon power sales for a part of the interest charges. It is realized, however, that the state would not be able to derive revenue from this source, should the federal government take over the completion of the project.

The permit given by the War Department to the Chicago Sanitary District authorizing the diversion of 8,500 sec.-ft. from Lake Michigan expires on December 31, 1929. There is reason for believing that the new permit will specify a smaller volume of water. In this connection it is stated that it has not been established that the completed Illinois waterway will require as much as 8,500 sec.-ft. It is thought significant that some of the canalized sections of the Ohio, designed for a much heavier tonnage, do not require this volume of flowage.

Propose New Cascade Tunnel

A 30 mile double-way "public utility" tunnel under the Cascade Mountains in Washington is proposed in a bill introduced in the House recently by Representative Hill of that state. A similar bill was introduced also by Representative Hadley, whose district is at the other end of proposed tunnel. These bills authorize an appropriation of $25,000, to be matched by a state appropriation of the same amount, for the purpose of completing the survey and location of the tube. Mr. Hill believes that such a tunnel would be of immense aid to vehicular traffic in removing the barrier interposed by the mountain range that practically divides the state. He believes, also, that the railways should be invited to give consideration to the project. The United States Forest Service has supervision over the land at both of the approach sites.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 14-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; annual meeting, New York, N. Y., Jan. 16-18.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

* * *

THE ASSOCIATION OF ASPHALT PAVING TECHNOLOGISTS at the recent annual meeting in New Orleans, La., elected Walter J. Emmons, associate professor of highway engineering, University of Michigan, as president. Mr. Emmons is also director of the State Highway Laboratory of Michigan.

THE CAROLINA BRANCH, Associated General Contractors, at a meeting in Charlotte, N. C., Dec. 16, agreed unanimously to support a workingmen's compensation bill before the next meeting of the state legislature. Officers elected were: President, Earl Whitton, Charlotte; vice-president at large, J. Roy Pennell, Spartanburg, S. C.; treasurer, V. B. Higgins, Charlotte; secretary, V. P. Loftis, Charlotte. The following were elected vice-presidents for the divisions noted: S. W. Thompson, Charlotte, highway division; R. K. Stewart, High Point, builders division; Paul N. Howard, Greensboro, public works division.

THE AMERICAN RAILWAY ENGINEERING ASSOCIATION has nominated the following as officers for 1929: President, Louis Yager, assistant chief engineer, Northern Pacific Railway; vice-president, L. W. Baldwin, president, Missouri Pacific Lines; secretary, E. H. Fritch, Chicago.

THE SIGNAL SECTION of the American Railway Association has nominated officers for 1929 as follows: Chairman, H. W. Lewis, signal engineer, Lehigh Valley Railroad; vice-chairmen, P. M. Gault, signal engineer, Missouri Pacific Railroad, and A. H. Rice, signal engineer and superintendent of telegraph, Delaware & Hudson Railroad. The secretary is H. S. Balliet, New York.

THE NEW YORK SECTION, American Water Works Association, will hold a luncheon meeting Dec. 28, at which E. E. Minor, general manager of the New Haven Water Company, will give an illustrated lecture on "Earth Current Surveys for Pipe Lines."

THE ROCHESTER ENGINEERING SOCIETY and the Rochester Section, American Society of Civil Engineers, held a joint meeting Dec. 14, which was addressed by Lincoln Bush and George T. Seabury, president and secretary of the American Society of Civil Engineers.

THE COLORADO ENGINEERING COUNCIL at a recent luncheon meeting heard Robert Ridgway, chief engineer of the New York City Board of Transportation, speak on "Some Facts About New York Subways."

THE DAYTON, OHIO, SECTION, American Society of Civil Engineers, elected the following officers at a meeting Dec. 10: President, C. H. Eiffert; vice-presidents, N. J. Bell and W. W. Morehouse; secretary-treasurer, C. S. Bennett.

THE MOHAWK VALLEY ENGINEERS CLUB met Dec. 13 at Utica, N. Y., to hear a description of the new Hudson River bridge by Allston Dana.

THE CIVIL SECTION, Engineering Society of Western Pennsylvania, will hold its annual meeting in Pittsburgh Jan. 8.

THE ASSOCIATION OF HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES will open its annual convention Feb. 13 at Atlantic City, N. J. At a meeting of the board of directors held Dec. 7, the following officers were elected: President, Stoddard B. Bates, Vermont; vice-president, Samuel Eckels, Pennsylvania; secretary-treasurer, A. Lee Grover.

Personal Notes

ROBERT N. WAID has been appointed state highway director of Ohio. For the past five years he has been chief engineer examiner in the office of the state auditor, and before this had served in the highway department as resident engineer, division engineer and chief engineer of maintenance. Mr. Waid is a graduate of Ohio State University.

ROBERT M. HOOKE, who recently retired from the post of city engineer of Chattanooga, Tenn., after 38 years of service, has been presented with a service cup by the Chattanooga Kiwanis Club as the man who has rendered the most conspicuous service to the city during the year 1928.

D. D. COCHRANE, who has been assistant engineer of the Metropolitan District Water Supply Commission of Boston, is now in the engineering department of the New England Public Service Company.

ERNEST L. MERRILL, division engineer with the Maine State Highway Commission, has recently been appointed assistant engineer in charge of state and federal-aid highways.

P. M. DAVIS, consulting engineer of Los Angeles, Calif., is now associated with the Southern Pipe Line Company and the Southern Crude Oil Purchasing Company at Hermit, Tex.

A. E. BECHTELHEIMER has been appointed assistant engineer of bridges of the Chicago & North Western Railway.

C. M. LIGHTBURN has been named a member of the committee of the Denver Chamber of Commerce formed to consider uniform traffic laws for the city.

Obituary

STEPHEN SANS BUNKER, for six years city engineer of Bangor, Me., died Dec. 15, at the age of 52. A graduate of the University of Maine, Mr. Bunker had spent most of his life in railway work in various parts of the United States and in South America. Before his appointment as city engineer Mr. Bunker was engineer for the Maine State Highway Commission. He was a member of the American Society of Civil Engineers.

EDWARD RICHARDSON WELLES, consulting engineer to the J. G. White Engineering Corporation and president of the Public Industrials Corporation, died Dec. 15 at his home in Brooklyn, N. Y. He was a graduate of Stevens Institute of Technology and had for many years specialized in public utilities. He had been at one time consultant for the War Industries Board on the Muscle Shoals project and also to a number of public utility companies in the United States and Canada. He was a member of the American Society of Mechanical Engineers.

Construction Equipment and Materials

Charge Patent Infringement on Steel I-Beams

Charging infringement of five patents with a value in excess of $250,000,000, the Bethlehem Steel Corporation and the American Universal Mill Company have filed suit in the federal court at Newark, N. J., against the United States Steel Corporation and its subsidiaries, the Carnegie Steel Company and the American Bridge Company. The suit seeks injunctions against the three defendant companies, an accounting of the profits accruing from the alleged infringements and payment of court costs and treble damages. The Bethlehem Steel Corporation has declined to make public more specific information as to the patents affected.

Concrete Paving Awards

The table below, prepared by the Portland Cement Association, summarizes the contracts let during November and during the calendar year up to Dec. 1 for concrete paving work in the classifications listed:

	Sq. Yd. Awarded in November, 1928	Sq. Yd. Awarded Jan. 1, 1928, to Dec. 1, 1928
Roads	5,212,553	88,365,542
Streets	2,954,992	47,934,025
Alleys	262,474	3,698,756
Total.	8,430,019	139,998,323

Steel Building Manufacturers Organize Trade Institute

At a meeting held Dec. 6 in Chicago a group of manufacturers organized the Standard Steel Building Institute, the purpose of which will be to acquaint American industry with the merits of standard steel buildings. C. I. Auten, of the Truscon Steel Company, Youngstown, Ohio, was elected president, and H. O. Davidson, Blaw-Knox Company, Pittsburgh, Pa., secretary-treasurer.

Softwood Standards Ready Soon

Substantial completion of the American lumber standards for softwoods was obtained at a meeting Dec. 7, in Chicago, of the central committee on lumber standards. The work of standardization was undertaken as the result of a general conference of lumber producers, distributors and consumers held under the auspices of the U. S. Department of Commerce. This conference gave the central committee on lumber standards power to consider all structural timber questions and to take final action on a number of features pertaining to national standards for softwood lumber in order to establish a revised simplified practice recommendation.

The findings of the committee include a statement that they are not for use as commercial-grading rules or for purchase specifications, but as bases for the formulation of grading rules by the manufacturers' association. Copies of the standards may be obtained from the Central Committee on Lumber Standards, 702 Transportation Building, Washington, D. C.

Specification Book Issued

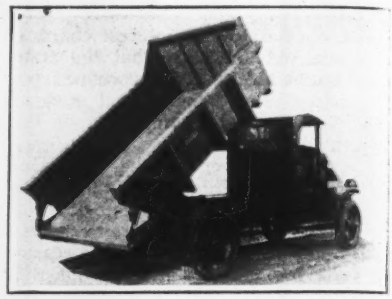
Standardized specifications for all types of modern buildings are given in a volume consisting of 608 loose-leaf pages which has been issued and prepared by Frank B. Stevens, Jr., structural consultant, Chicago, Ill. The volume has been prepared to assist the architect or engineer in preparing building contracts, avoiding duplications and omissions and preventing misunderstandings with contractors.

The first part of the book is devoted to general conditions and instructions to bidders, and includes both the standard form of contract drawn up by the American Institute of Architects and a description of the A.I.A. standard filing system, which is used throughout the book. Following these are detailed specifications, in separate units, for each of the operations necessary in constructing a new building, including wrecking, foundations, masonry, concrete, waterproofing, structural steel and others to a total number of 35. At appropriate points throughout the volume there are advertising inserts describing various building products. Distribution is through Stevens Master Specifications, Inc., Chicago, Ill.

New Developments

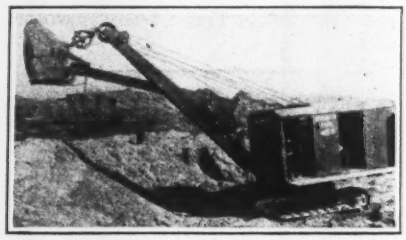
Steel Truck Bodies Built for Rough Service

Originally brought out for heavy-duty service in quarries, the models of all-steel auto truck bodies of the Easton Car & Construction Company, Easton, Pa., have proved so well adapted to extremely heavy service that they are now being used by contractors where bodies of unusual durability are desired. They are available in either rear-dump or side-dump style with or without power self-contained hoists. The bodies are of all-steel construction, securely riveted together, and are designed to develop excessive strength. The floors have wood and steel plate liners, the former to absorb the shock of loading, the latter to stand the wear that occurs from steam-shovel operation. In the rear-dump body which is shown in the illustration, the tailgate is rigidly supported by a special linkage and can dump without damage any size of stone which can be placed in the body. The same is true of the side-dump body, although the gate construction is different. The ruggedness of the construction may be judged from the fact that the 5-yd. side-dump body and dump frame weighs 6,500 lb., the 8-yd. end-dump body 7,500 lb., and others in proportion. The manufacturers recommend that the rear spring suspension of the truck used with these bodies be strengthened.



Announce New 1¼-Yd. Shovel

Following closely the announcement of a new 2-cu.yd. (Type 480) shovel described in *Engineering News-Record*, Nov. 29, 1928, p. 824, the Marion Steam Shovel Company, Marion, Ohio, has brought out a smaller machine along similar lines with a capacity of 1¼ cu.yd. Three types of power are available in this line—electric, gas-electric and Diesel-electric. The design follows closely that of the old Marion Type 7 1-cu.yd. shovel, which it supersedes. In spite of the greater bucket capacity, it is claimed that very little more space is required and that the unit will operate in practically the same space as is needed for the Model 7. Crawlers have been lengthened about 1 ft. to provide additional stability, booms are 22 ft. long and dipper handles 15 ft. A boom hoist is standard equipment.



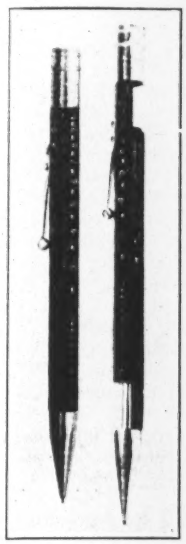
Power for the gas-electric models is supplied by a 92-hp. gasoline engine which drives a 25-kw. (continuous rating) direct-current "drooping voltage" generator. The remainder of the machine is identical with the electric model, which has 30-hp. hoist motors and 12½-hp. motors for swing and crowd. These are continuous ratings; both motors and generators are capable of the short-period overloads typical in shovel service.

In the Diesel model, the power plant is a Buda M.A.N. 92-hp. motor fitted with fuel oil pump, water pump, fuel

oil filter, lubricating oil filter and starter. Aside from the power source, the machine is identical with the gas-electric.

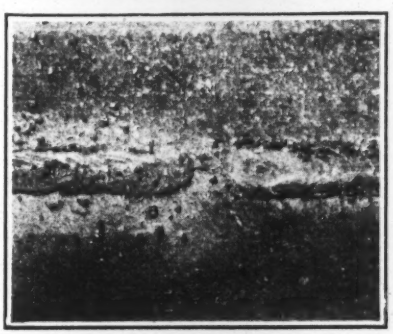
Automatic Pencil Graduated as Slide Rule

Quick calculations in the field can be made by means of a combination automatic pencil and slide rule now being distributed by the Ruxton Multi-Vider Corporation, No. 2445 Graybar Building, New York City. The pencil is 6½ in. long, approximately ⅜ in. in diameter and carries four 4-in. logarithmic scales engraved by a precision machine. The barrel, which is made of Bakelite, is split, the two halves sliding in relation to each other by means of a metallic strip and groove on the inside of the hollow barrel. It is used in a manner similar to the ordinary slide rule. The outside metal parts of the automatic pencil are 14 carat gold filled, the inside parts of spring brass, nickel plated. The lead of the pencil is propelled in either direction by rotation of a movable sleeve at the lower end. For the benefit of those unfamiliar with the slide rule, a simplified instruction booklet is furnished with each pencil.



New Electrode Permits Higher Welding Speeds

As the result of much experimentation and research, a new type of welding rod has been developed in the laboratories of the Lincoln Electric Company, Cleveland, Ohio, and will soon be put in commercial production. This electrode, which will be known as "Fleet-Weld," is an extruded wire that permits high-speed welding without loss of ductility to the weld metal. It is claimed that the newly developed electrode overcomes the previous disadvantages of speeding up welding, in that it eliminates porosity and gives great ductility and penetration. A comparison of the results obtained from the old type rod and the new is given in the illustration, which shows side and top views of a typical weld, the portion on the left being made with the old type electrode, that on the right with "Fleet-Weld."



Business Notes

ROME BRASS & COPPER COMPANY, Rome, N. Y., incorporated under the laws of Maryland, has filed with the Secretary of State of New York a statement to enable it to do business in the latter state.

EASTERN STEEL CASTINGS, Newark, N. J., has acquired the American sales rights for the process of making the new Perlite metal, which is now being used extensively abroad. Manufacture of the new metal is planned for early next year.

AMERICAN STEEL & WIRE COMPANY, Chicago, Ill., has appointed Wilmer Cordes manager of its advertising department.

CAST IRON SANITARY SEWER COMPANY, Chicago, Ill., has appointed Samuel Karrakis metropolitan district agent for the New York territory. Mr. Karrakis is general sales manager of the All Cast Iron Sanitary Sewer Appurtenance Company, Inc., Brooklyn, N. Y.

SHEET STEEL TRADE EXTENSION COMMITEE has appointed the Gardner Advertising Company as advertising counselor for the general division and the Griswold-Eshleman Company to advise the farm division.

TIMKEN ROLLER BEARING COMPANY, Canton, Ohio, has established two new permanent offices on the Pacific Coast, one in Los Angeles, Calif., in charge of Roy Cross; the other in Seattle, Wash., in charge of Marshall Cooledge. The San Francisco office remains, as before, in charge of G. C. McMullen.

Manufacturers and Trade Associations

CALENDAR

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 9-11, 1929.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C., annual convention, Cleveland, Ohio, Jan. 14-18, 1929.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; annual convention, Clevalnd, Ohio, Jan. 21-24, 1929.

New Publications

Drainage Gates — CALIFORNIA CORRUGATED CULVERT COMPANY, Los Angeles, Calif., has issued "Efficient Water Control at Moderate Cost," a booklet describing various types of irrigation and drainage control gates produced by this company and giving photographs showing typical installations. The book contains a number of tables and diagrams giving hydraulic data of value to designers and devotes several pages to the use of the Calco headgate as a water meter by means of standardized installations developed and tested by the Fresno Irrigation District.

Single-Phase Motors — WAGNER ELECTRIC CORPORATION, St. Louis, Mo., in Bulletin 157 gives a detailed discussion of single-phase repulsion induction electric motor construction. The book gives a good idea of the design principles and includes a history of the development of this type of machine.

Centrifugal Pumps — DAYTON-DOWD COMPANY, Quincy, Ill., has issued Bulletin 267, superseding Bulletin 249, which describes the double-section, single-stage centrifugal pumps manufactured by the company. Models are described suitable for low, medium and high head service, and for waterworks, filtration plants, drainage and irrigation plants and similar installations.

Gravel Washing Plants—LINK-BELT COMPANY, Chicago, Ill., has issued Book 640 devoted to plants for washing sand and gravel. This is an unusually well-made 78-p. book, combining informative text with interesting pictures. It describes four types of settling and dewatering devices for the preparation of sand and gravel, including the dewatering flight conveyor, the dewatering screw conveyor, the Dull conical sand separator and the Shaw classifier. Excavating and conveying mediums for sand and gravel are also described, and more than 50 views of sand and gravel plants in the United States and Canada are given.

Sheet Steel — INLAND STEEL COMPANY, Chicago, Ill., describes its copper alloy steel sheets in a 30-p. illustrated booklet which contains data regarding corrosion tests conducted by the American Society for Testing Materials for determining the life of steel sheets. A review of the production process of the steel industry is also given, as well as a number of photographs showing the products of the company in use.

Brickwork—AMERICAN FACE BRICK ASSOCIATION, Chicago, Ill., has issued a 26-p. illustrated book "Wet Walls and Efflorescence," containing a summary of two investigations of efflorescence on masonry walls conducted for the association by the National Bureau of Standards, Washington, D. C. These results were summarized briefly in *Engineering News-Record*, Nov. 20, 1928, p. 770.

The Business Side of Construction

Wages Reach Highest Level Since 1920

Industrial wage earners' incomes this fall reached their highest level since 1920, a year of inflation, and employment in manufacturing was at the highest point since April, 1927, according to the monthly reports made to the National Industrial Conference Board by approximately 1,500 manufacturing establishments employing on the average about 800,000 workers.

The outstanding phenomenon in the labor situation, however, according to the board's analysis, is the marked stability of wage rates and earnings, which since 1923 have fluctuated less than 5 per cent and during the current year have shown a slightly upward trend.

Employment in September was more than 6 per cent higher than at the low point in November, 1927, and 4 per cent higher than in September a year ago. Not only was the number employed larger but the total number of hours worked by them in September was 10.8 per cent greater than that in the low month of November, 1927, and 6.2 per cent greater than September a year ago.

These figures, however, the Conference Board points out, are averages based upon the reports from individual plants in 25 different industries and hence reflect greater improvement in some than in others. Weekly and hourly earnings per worker during September increased in eighteen different industries: In the manufacture of agricultural implements, automobiles, boots and shoes, chemicals, cotton (in the North), hosiery and knit goods, iron and steel, in leather tanning, meat packing, paint and varnish, paper products, rubber, silk, foundry and machine shops, machines and machine tools, heavy equipment hardware and small parts. In seven of these—that is, in the automobile industry, boot and shoe plants, the iron and steel industry, meat packing, paint and varnish, rubber and heavy equipment manufacturing—average weekly earnings per worker increased by $1 or more over the previous month. In book printing weekly earnings increased; in news and magazine printing they decreased slightly.

Month	Average Hourly Earnings (July, '14 = 100)	Average Weekly Earnings (July, '14 = 100)	Employment (June, '20 = 100)
1927			
September	233	218	79.8
October	233	215	79.7
November	232	213	78.2
December	232	215	78.4
1928			
January	232	217	79.1
February	231	218	80.8
March	233	220	81.2
April	233	217	80.7
May	231	217	81.2
June	233	218	81.1
July	232	216	61.8
August	233	218	82.1
September	234	221	83.0

E. N.-R. Index Numbers

	Cost		Volume	
Dec. 1,	1928	210.16	November, 1928	251
Nov. 1,	1928	209.46	October, 1928	363
Dec. 1,	1927	203.90	November, 1927	272
Average,	1927	206.24	Average, 1927	263
Average,	1926	208.03	Average, 1926	228
1913.....		100.00	1913.....	100

Average weekly earnings per worker in all the 25 industries increased by 41 cents over the previous month.

The Conference Board's wage data's claim to exceptional accuracy of the trend of wage earnings and employment rests on the fact that the monthly reports are collected always from a representative number of identical plants throughout the United States in a sufficiently large variety of major industrial activities as to give a true picture of the industrial situation as a whole. The accompanying table of index numbers shows the trend of average hourly and weekly earnings per worker and of employment for the period September, 1927, to September, 1928.

One of the most favorable economic factors tending toward a continuance of present prosperous conditions is the decrease in unemployment and a continued upward trend in wages with the cost of living remaining about stationary, resulting in a widely distributed high consumer purchasing power. The mere fact that record manufacturing activity is prevalent does not in itself reflect prosperity or even a sound economic condition, for such a condition, while it undoubtedly implies a large volume of aggregate purchasing power, must be backed by a widely distributed high consumer purchasing power. The record manufacturing operations of the past year have been balanced by a ready demand of the consumer, a demand which has been even stronger with the enhanced position of the American farmer. According to the latest data of the National Industrial Conference Board, the present purchasing power is 55 per cent over that of 1909 and in current dollars is 173 per cent over 1909. The increase in real purchasing power per capita is 20 per cent over 1909 and that of the gainfully employed is 35 per cent over 1909.

As a result of these economic conditions there has been an ever-increasing spread between the wages received by American labor and the cost of living, leaving a greater and greater margin available for recreation, saving, insurance and the purchase of manufactured products. At the opening of last year the statement was made that the limit of this spread between income and the cost of living had been reached, but 1928 appears to have increased this margin even further. And yet the present income of the American wage earner, especially among the 65 per cent of the population classed as the "poore group," is not such as to warrant the experiencing too much prosperity that they are getting more wages than they know how to spend.

Business Continues Good

The intensive studies of the Standard Statistics Company indicate that the general business outlook is still highly favorable, all things considered. Expansion in leading industries has made impressive progress this fall in spite of the credit situation, and the year 1928 will close with more industries and more individual companies in a strong position than at any time in recent years. The three key industries—automobiles, building and steel—have been leading factors in the tremendous industrial activity registered this year. Automobile production in the first ten months exceeded that of twelve months in 1927. Allowing for rapidly expanding Ford production to offset most of the seasonal lull in other plants, the indications are that output for the entire year will be 30 or 35 per cent greater than in 1927, exceeding the former record established in 1926 by 6 or 7 per cent. Building construction beyond a doubt will reach heretofore unattained volumes this year.

Material Increase in Awards for Commercial Buildings

The week ended Dec. 18 witnessed a volume of contracts awarded on about the same level as for the week previous but about 21 per cent under that of the corresponding week of last year. The volume of contracts awarded for commercial buildings, however, was more than double that of the week previous and 25 per cent over last year. The increase in commercial building awards this week as compared with the week previous was due to number rather than to value of projects. The current week awards numbered 81, as against 50 for the week of Dec. 11. The one big commercial building contract was for an apartment in St. Louis at a value of $5,000,000 and the 28-story building of the Park Plaza Building Corporation.

The accumulated total for the year to date is $3,598,413,000, an increase of about 13.5 per cent over last year.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Dec. 18, with some comparisons, total as follows:

(In Thousands of Dollars)

	Dec. 18, 1928	Dec. 11, 1928	Dec. 20, 1927
Buildings:			
Industrial.....	$5,386	$4,199	$17,446
Commercial.....	30,143	14,677	24,123
Streets and roads..	3,992	2,491	8,163
Other construction.	11,996	30,420	15,644
Total.....	$51,517	$51,787	$65,376
Total, all classes, Jan. 1 to Dec. 18:			
1928.....			$3,598,413
1927.....			3,173,317